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COTTON DUST

Proposed Standards for Exposure and Notice of Hearing

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

[29 CFR Parts 1910 and 1928]

[Docket No. H-052]

OCCUPATIONAL EXPOSURE TO COTTON DUST

Proposed Standards and Notice of Hearing

Pursuant to sections 6(b) and 8(c) of the Occupational Safety and Health Act of 1970 ("the Act") (84 Stat. 1593, 1599; 29 U.S.C. 655, 657), Secretary of Labor's Order No. 8-76 (41 FR 25059) and Title 29, Code of Federal Regulations ("CFR"), Part 1911, it is proposed to amend Part 1910 of 29 CFR by adding a new occupational safety and health standard for exposure to cotton dust as 29 CFR 1910.-1043, and by deleting the present standard for "cotton dust (raw)" contained in Table Z-1 of 29 CFR 1910.1000. This standard would apply to all employments in all industries covered by the Act, including "general industry," construction, maritime and agriculture except harvesting.

In addition, pursuant to section 4(b)(2) of the Act (84 Stat. 1592, 29 U.S.C. 653), if th standard, when promulgated, is determined to be more effective than corresponding standards now applicable to the maritime and construction industries contained in Subpart B of Part 1910, Parts 1915, 1916, 1917, 1918, and 1926 of 29 CFR, the new cotton dust standard will supersede the corresponding maritime and construction standards for exposure to cotton dust. Appropriate conforming amendments will be made in Subpart B of Part 1910, and amendments to delete the superseded standards and replace them with references to the new cotton dust standard will be made in 29 CFR 1926.55 and in similar sections of Parts 1915-1918.

Further, to clarify the proposed application of the cotton dust standard to agricultural operations including cotton ginning (but excluding harvesting), it is proposed to amend 29 CFR 1928.21 to add the cotton dust standard to the list of standards applicable to agriculture.

During Fiscal Year 1977, which ends on September 30, 1977, OSHA is subject to a rider attached to the Department of Labor-Department of Health, Education, and Welfare Appropriations Act (Pub. L. 94-439), which prohibits, among other things, the expenditure of funds to prescribe or issue any standard which is applicable to any person engaged in a farming operation and employing 10 or fewer employees. Accordingly, to the extent that there are farming operations (such as cotton ginning done on the farm) which would otherwise be covered by this standard but which employ 10 or fewer employees, this standard would not be applicable to such operations so long as the rider remains in effect.

The accompanying document is a proposal issued pursuant to sections 6(b) and 8(c) of the Act. As explained more fully below, the agency requests the submission of written comments, data, and arguments from interested persons on the various issues specifically addressed or implicit in the proposal. In addition, pursuant to section 6(b)(3) of the Act, there will be an informal rulemaking hearing to provide further opportunity for presentation of evidence and discussion of the issues. After the hearing the Occupational Safety and Health Administration (OSHA) will issue a final standard based upon the full record in the proceeding.

Very briefly, the proposed standard provides for a permissible employee exposure limit of 200 micrograms of vertical elutriated cotton dust per cubic meter of air (200 $\mu g/m^3$) averaged over any eight-hour period. The proposal also provides for, among other things, the measurement of employee exposure, methods of compliance, personal protective equipment, training, work practices including housekeeping, medical surveillance, signs and recordkeeping.

Some of the major issues raised in this proposal on which comment is requested include the following:

(1) Whether the proposed application of the permissible exposure limit for cotton dust to all employments in all industries covered by the Act, including "general industry", maritime, construction, and agriculture, but excluding harvesting, is appropriate.

(2) Whether different standards should be set for different industries involved with cotton dust, such as ginning, merchandising, textiles, cottonseed oil manufacturing, waste utilization operations, etc., or for various operations within industries, especially weaving, knitting and subsequent processes such as dyeing.

(3) What is the impact of seasonal employment on the hazards of exposure to cotton dust.

(4) Whether present knowledge of the physiological response to cotton dust is sufficiently developed to set different standards for cotton dusts generated from different varieties of cotton grown in different regions and generated in the wide variety of industrial processes.

(5) Whether the selection of the substance to be regulated, namely vertical elutriated particulates, is appropriate.

(6) Whether the proposed permissible exposure limit of 200 $\mu g/m^3$ incorporate an appropriate margin of safety for all affected employees.

(7) Whether the prevention of reversible symptoms or reversible physiological changes should be considered in establishing a standard, such as this one for exposure to cotton dust.

(8) Whether the proposed compliance schedule is technologically feasible; what are the expected compliance costs and ability of the affected industries to comply.

(9) Whether the proposed provisions for employee exposure measurements, compliance procedures, work practices, medical surveillance, protective equipment and recordkeeping are appropriate.

(10) Whether certain aspects of the medical surveillance proposed should be conducted by a non-physician and if so what training or certification should be required.

(11) Whether there are groups with increased susceptibility to cotton dust in the working population, such as smokers and asthmatics, and whether such susceptibility, if it exists, should be considered in establishing a standard for occupational exposure to cotton dust.

(12) Whether medical measurements, mainly pulmonary function measurement, need to be applied differently to different ethnic groups.

(13) What requirements should be established where, as a result of the medical surveillance program, it is determined that an employee is at increased risk.

(14) Whether the standard should include specific requirements for methods and equipment to be used in conducting pulmonary function tests and, if so, what is appropriate.

(15) Whether, as proposed, cleaning of equipment, and surfaces using compressed air ("blow-downs") should be prohibited or restricted to a time when only personnel doing such work are present and using personal protective equipment.

I. Background

A. General

Cotton is commercially grown in at least nineteen States and is a major crop in fourteen. The states generally considered to be the largest producers of cotton are Texas, California, Mississippi and Arkansas. Between ten and thirteen million bales (480 lbs. net wt.) of cotton lint are produced annually in the United States. At the farm level, cotton was worth almost $3 billion in 1973 and more than $12 billion at retail levels. The number of workers involved in cotton fiber processing alone was estimated by OSHA in 1973 to be at least 800,000.

The cotton industry of the United States can be divided into eleven processes: (1) harvesting; (2) ginning; (3) warehousing and compressing of cotton lint; (4) classing and marketing of cotton lint; (5) yarn manufacturing using cotton lint; (6) fabric manufacturing using cotton yarn; (7) reclaiming and marketing of textile manufacturing waste; (8) delintering of cottonseed; (9) marketing and converting of linters; (10) reclaiming and marketing of ginmotes; and (11) batting, yarn and felt manufacturing using waste cotton fibers and byproducts. Within each of these major processes there are various stages, distinct work procedures and methods of operation.

Less than 15 percent of the cotton crop is grown in the southeastern states where the textile industry is concentrated. Thus, a large proportion of the crop is transported long distances to domestic mills or to ports for export. Most of the crop is harvested and ginned in the fall and early winter; it is processed by domestic and foreign mills on a year round basis. Hence, storage and transportation are major elements of the entire cotton industry.

As soon as cotton is harvested it is usually hauled to a nearby gin. The gin has features which are similar to a fixed industrial work place such as a textile

mill. After the seed cotton arrives at the gin, it is exposed to multiple stages of conditioning and cleaning most, if not all, of which result in cotton dust exposures. The line is separated from the seed and packaged into bales weighing approximately 480 pounds.

After ginning most cotton lint moves into a warehouse for storage or a compress for hydraulic pressing to higher density pending shipment to cotton mills or ports for export. Bales are initially sampled at the gin or warehouse for the United States Department of Agriculture classification which is furnished to cotton producers under the United States Cotton Standard Act (7 U.S.C. 51–65). Bales are usually resampled by warehousemen and reclassed by merchants or shippers one or more additional times as they move through marketing channels. Transportation, storing and sampling of cotton all involve employee exposure to cotton dust primarily as a result of cotton dust being generated into the atmosphere by the handling of cotton.

Cotton lint arrives at the textile mill in hydraulically compressed packaged bales. At the mill the bale covering is removed and the contents are passed through the opening machinery which exposes it to successive processes of intense decompression, beating, cleaning, and mixing. During these operations, dirt and other heavy impurities are removed by gravity or by centrifugal force through grids or screens. Cotton from the opening equipment is usually conveyed pneumatically to the picker room where it is fed evenly to the pickers which further open and clean the cotton and deliver either a picker lap, a flat thick batt of randomly oriented fibers, or pneumatically conveyed loose cotton lint to the carding machinery. Carding machines comb the fiber so that it lies straight and parallel and some cleaning is also effected. Large quantities of dust can be produced by this process and the card room has traditionally been one of the dustiest workrooms in a mill. The main processes in a spinning mill after carding are: drawing to obtain thorough fiber mixing and weight uniformity, roving to draw the sliver down to one fourth to one-eighth its original size and slightly twist it, and spinning to give considerable fine draft to the soft roving and twist it into yarn. Processes subsequent to spinning are only amalgamation of yarn units or changes in the form of package and result in the production of a yarn in a form suitable for dispatch to the fabric manufacturing mill. Weaving is the process of interlacing two sets of yarn, one running lengthwise on a loom, the other crosswise, by means of a shuttle. This results in a woven fabric, ready for finishing processes such as dyeing.

Textile wastes are usually packaged into bales at the textile plant, frequently in a separate building or work area referred to as the waste house, and sold to textile waste dealers or directly to textile waste processing plants. At the waste processing plant the bale covering is removed, the contents are passed through a hand opening and cleaning process for removal of gross debris such as paper and pieces of metal caps from floor sweepings and then through machinery which exposes the contents to successive processes of intense beating, cleaning and mixing before rebaling and storage pending sale to the spinning trade for use in yarn and the felting trade for use in batting and felting. As this description indicates, waste processing is an extremely dusty operation.

The cottonseed is separated from the cotton lint at the gin. From the gin, most cottonseed moves into oilseed processing. Cotton linters, the short fibrous material adhering to cotton seed after ginning, are removed from the seed by machines before the seeds are crushed.

Gin motes are a byproduct of the cotton ginning process consisting of any cotton waste useable for its fiber content. Gin motes may be cleaned and baled at the gin, usually in a building separate from the gin plant, or sold in loose form to mote cleaning plants which pick up motes in bins or trailers at regular intervals. At the mote cleaning plant the loose gin motes and the unclean baled gin motes are cleaned or reclaimed, baled and stored pending sale to the spinning trade for use in yarn and to the felting trade for use in batting and felting.

Three types of waste cotton fibers and byproducts are used in manufacturing batting and felting for bedding, automotive uses, upholstered furniture and thermal insulation: cotton linters, gin motes and cotton mill wastes. All of the cotton fibers and byproducts used in mattress felts and related products arrive at the batting manufacturers in packaged bales. At the plant the bale covering is removed and the contents are passed through opening and mixing machinery which exposes it to successive processes of decompression, beating, cleaning and mixing. Cotton from opening equipment is sucked up to a condenser before it is delivered to the garnetting machinery. The garnet consists of two main cylinders and many smaller ones which further separate and form the fibers into fine web, causing much of the trash to be liberated.

The proportion of cotton to synthetic fiber in textile goods has generally decreased in recent years with the advent of newer texturizing processes for synthetic fibers. However, processed cotton has certain desirable properties which make it unlikely that complete substitution by synthetic fibers would ever occur. Among these are its properties of moisture absorbancy, coolness, softness, ready adaptability into leisure fabrics such as denim and corduroy, and economy of use. In addition, substitution of synthetic fibers results in increased use of petroleum products and other forms of energy.

B. HISTORY OF REGULATION

Although textile workers have long been know to suffer from a high prevalence of respiratory disease, substantial improvements relating to working conditions in the cotton textile industry did not occur until well into the twentieth century. The most imporant early improvements came in England as a result of legislative acts requiring medical inspection of workplaces, compulsory reporting of industrial diseases and compensation of the diseased and disabled workers. In 1942 a compensation scheme was introduced in England as a means of implementing the Factory Act of 1937 and associated legislation which for the first time recognized byssinosis as an occupational disease.

At that time byssinosis was thought to be confined to British cotton mills. Even as recently as 1961, its occurrence in the United States was said to be almost nil. Ten years later prevalence of byssinosis in the United States on the order of 20–30 percent was found in carding operations. (*16*) In 1964 the American Conference of Governmental Industrial Hygienists (ACGIH) placed cotton dust on its tentative list of threshold limit values, and in 1966 they adopted a 1000 ug/m^3 of total cotton dust as their recommended value for exposure. This TLV was based upon the work of Roach and Schilling (*1*) in the Lancashire cotton mills. Exposure to cotton dust was not regulated in the U.S. until 1968, when the Secretary of Labor under the Walsh-Healey Act (41 U.S.C. 35 et seq.), promulgated the 1968 ACGIH list of Threshold Limit Values which included a "cotton dust (raw)" limit of 1000 ug/m^3. This standard was subsequently adopted as an established Federal standard under section 6(a) of the Occupational Safety and Health Act of 1970. In 1972, the British Occupational Hygiene Society (BOHS) published a report, largely based upon Molyneux and Berry's "Correlation of Cotton Dust Exposure with the Prevalence of Respiratory Symptoms. (*55*)" recommending a new standard of 500 ug/m^3 less "fly"; the term fly meaning dust particles removed by a 2-mm wire screen. In addition, in 1972, on the basis of BOHS and others, a revision of the TLV was recommended that would measure respirable dust rather than "total dust". In 1974, a TLV of 200 ug/m^3 of cotton dust as measured by the vertical elutriator was adopted by ACGIH. The rationale was stated as follows:

> Molyneux and Berry, in a 3-year prospective study of cardroom workers in Lancashire, concluded that two components of the total dust, the "respirable" and "medium" fractions correlated significantly with the prevalence of respiratory symptoms. The committee of Hygiene Standards of the British Occupational Hygiene Society stated on the basis of this study that a concentration of 0.3 to 0.4 mg/m^3 of "fly-free" dust results in 20 percent byssinosis. ("Fly-free" cotton dust is the sum of respirable and medium length fibers. At an average level of 0.46 mg/m^3 fly-free dust, 6 percent Grade II byssinosis occurred. Merchant, Lumsden and Kilburn using the vertical elutriator sampler, showed a byssinosis (all grades) prevalence of 20 percent at 0.3 mg/m^3 of dust with fiber length less than 15 um. In slashing and weaving areas of the mills, only 6 percent byssinosis, all grades, occurred at 0.5 mg/m^3. A probit line of best fit of the data indicated that raw, untreated cotton would result in 3 percent byssinosis at 0.05 mg/m^3, 7 percent at 0.1 mg/m^3, 13 percent at 0.2

mg/m³. The BOHS Committee further determined that less than one case of Grade II byssinosis occurred per five cases of byssinosis all grades, at 0.5 mg/m³. Thus, the 13 percent byssinosis, all grades found by Merchant et al. in this country at 0.2 mg/m³ would result in considerably less than 3 percent Grade II byssinosis. Moreover, Merchant et al. have shown that a concentration of 0.2 mg/m³ in the cotton preparation room was equivalent in byssinosis production to 1 mg/m³ in the slashing and weaving areas.

From the statistical treatment of the data, the interpretation of the findings of Merchant et al. would appear to be that there is no readily measureable limit for raw cotton dust that will completely eliminate Monday morning "chest tightness" and reduction in 1-second forced expiratory volumes.

Accordingly, a TLV for raw cotton of 0.2 mg/m³ of dust composed of fibers less than 15 um in length is recommended. The limit is intended to prevent Monday morning chest tightness in most of the workers so that the more susceptible may be detected and transferred out of the exposure before irreversible damage to health results.

On September 26, 1974, pursuant to section 20(a)(3) of the Act, the Director of the National Institute for Occupational Safety and Health (NIOSH) submitted to the Secretary of Labor a criteria document containing a recommended standard for cotton dust. Among other things, the significant sections of the recommended standard included medical management and surveillance, personal protective equipment, posting of signs, exposure monitoring, informing employees of the hazards of cotton dust, recordkeeping and work practices. The NIOSH recommendation was intended to apply to all employments in all segments of the cotton industry. The document stated that "since no definitive environmental level can assure complete health protection, none is recommended * * *. However, to ensure that effective engineering controls are implemented and dust concentrations reduced, an environmental standard should be fixed. The concentration should be set at the lowest level feasible in order to reduce the prevalence and severity of byssinosis."

On December 6, 1974, NIOSH forwarded to the Assistant Secretary of Labor for Occupational Safety and Health a memorandum which modified the recommendation in the criteria document that the dust concentration should be set at the "lowest feasible" concentration. He stated

> * * * that byssinosis has been reported in workers exposed to as little as 0.05 milligrams of cotton dust per cubic meter of air (mg/cu m). It was also reported that byssinosis has resulted from exposure to cotton dust below this concentration. However, background dust levels near 0.1 mg/cu m are indistinguishable from cotton dust by available sampling methods. We believe that a level of 0.1 to 0.2 mg/cu m of lint-free cotton dust is feasible to measure and achieve, but these concentrations have been found to cause byssinosis in some workers. (*78*)

NIOSH also stated that the standard should be set in no case at an environmental concentration as high as 200 ug/m³ lint-free cotton dust. The NIOSH memorandum states its purpose is to "explain (the) rationale for the recommendation (of the lowest feasible level in the criteria document) and to offer a modification * * *" that hopefully would clarify any misunderstanding. On December 27, 1974, OSHA published an advance notice of proposed rulemaking (39 FR 44769) requesting that interested persons submit their views on specified issues relating to cotton dust, particularly the NIOSH Criteria Document.

In early 1975, petitions were filed by the Textile Workers Union of America and the North Carolina Public Interest Research Group with the Department of Labor requesting modification of the cotton dust standard to provide, among other things, a permissible exposure level of 100 ug/m³ cotton dust. (*62*)

II. Occupational Health Implications of Exposure to Cotton Dust

Chronic obstructive lung disease is one of the most common causes of premature disability retirement in the United States. It can also lead to premature death. The major cause of chronic lung disease is believed to be external irritants which are breathed into the lung. Significant contributing factors include cigarette smoking, air pollution and industrial exposure.

Workers exposed to cotton dust have been known to suffer from a high prevalence of respiratory diseases. (*15–20*) This fundamental association between cotton dust and increased prevalence of respiratory diseases has been recognized for almost a century.

However, as recently as twenty-five years ago, chronic respiratory disease due to exposure to cotton dust was thought to be confined to English cotton mills. It has since been described in countries all over the world including the U.S., and among workers in a wide range of exposure processes ranging from the ginning of cotton through the manufacturing of fabric using cotton yarn and the use of waste cotton fibers and byproducts. Studies by Schrag and Gullett (*14*) Bouhuys, (*15, 16*) Zuskin (*2*) Merchant (*44*) and others (*17, 18, 19*) have definitely established the existence and severity of respiratory disease from exposure to cotton dust in the U.S.

While byssinosis, the specific occupational disease, is responsible for many of the symptoms in workers exposed to cotton dust, exposure also results in the production or aggravation of respiratory symptoms characteristic of chronic lung disease, i.e., chronic bronchitis, asthma, emphysema and other non-specific disorders.

A. BYSSINOSIS

Ramazzini, (*7*) writing in 1713 of flax and hemp workers, described symptoms characteristic of byssinosis. Many descriptions were given to the chronic respiratory disease suffered by textile workers; such conditions were reported in France in 1822 and 1827, (*8*) and in England in 1832. (*9*) In 1877, Adrien Proust described the syndrome as "byssinosis," which has continued to be used as the name for this occupational disease. (*67*)

Byssinosis is a specific respiratory disease, the symptoms of which are attributable to the action of cotton dust on the respiratory passages. The effects of byssinosis can be temporary or permanent, depending upon the exposure and the individual, and can lead in time to chronic obstructive lung disease, primarily chronic bronchitis. (*20, 21*) Initially, the individual notices a tightness in the chest occurring on the first day of the work week. The tightness may be accompanied by a measurable decrease in breathing capacity as measured by pulmonary function tests. Usually, the condition is mild and temporary at first, tending in time to progress to the stage where it bothers the workers on other days of the work week. This progression, which is characterized by constriction of the bronchial tubes of the lung, leads to a permanent narrowing of these airways. The individual develops a chronic cough with a production of phlegm and increasing shortness of breath. At this stage, the condition is readily detectable by pulmonary function measurements. Total disability and even death may follow. The description of these detailed symptoms appeared as early as 1908 in the work of Collis. (*10*)

As a result of the obvious subjective quality of the early symptoms of byssinosis, investigators have, in the past few years, subdivided byssinosis into different categories for purposes of diagnosis and treatment, namely: (a) the reversible symptomatic or physiological condition (sometimes referred to as a reactor state), and (b) the chronic irreversible lung disease.

Schilling (*22, 23*) distinguished the reversible symptoms of Grade one-half, Grade one, and Grade two byssinosis from the permanent incapacity which he labeled Grade three byssinosis. According to Schilling's classification byssinosis is graded as follows:

(a) Grade one-half—occasional chest tightness on the first day of work week.
(b) Grade one—chest tightness and/or breathlessness on Mondays only.
(c) Grade two—chest tightness and/or breathlessness on Mondays and other days.
(d) Grade three—grade two symptoms accompanied by evidence of permanent incapacity from diminished effort tolerance and/or reduced ventilatory capacity.

1. *Grades 1/2 to 2 (the reactor state).* After a variable time period, usually at least several years, a worker exposed to cotton dust develops a sensation of tightness in the chest, difficulty in breathing, increased coughing, and perhaps wheezing after coming to work on the first day of the work week, after being absent one or two days. Workers often notice that this reaction is more severe when intervals away from work have been more prolonged, such as after a vacation or an illness.

Bouhuys (*24*) observed that exposed workers also exhibit a measurable decrement in pulmonary function as measured by several techniques. Forced Expiratory (FEV_1) Volume for one second (FEV_1) is a widely used measurement and has shown significant decreases during the

first day of the work week in workers with symptoms characteristic of grades 1/2 to 2. However, some workers may exhibit tightness in the chest without any decrement in FEV_1, and still others may exhibit this decrement without the corresponding symptoms. (*18,19, 3, 24*). Other means of diagnosis, such as flow volume determinations, (*25*) closing volume determinations, and maximum mid-expiratory flow (MMF) (*26*) have been evaluated. Flow volume and MMF are more sensitive measurements and thus are more likely to decline with exposure to cotton dust than FEV_1. A satisfactory explanation has not been offered why some individuals complain of the tightness while others exhibit the decrement in pulmonary function without such complaints. The possibility that the subjective symptoms may be due to constriction of smaller airways, whereas the FEV_1 is more likely to decrease with constriction of larger airways, has been suggested by some as a possible explanation. (*27*) It is clear, however, that there is no generally accepted single diagnostic method of detection for the disease in the reactor state of Grades 1/2 –2.

2. *Grade 3 (the chronic irreversible disease).* In this advanced stage the clinical picture often becomes confused, as the chronic disease process is neither well understood nor well defined. Workers frequently manifest symptoms consistent with chronic bronchitis and emphysema. This stage is generally considered to be irreversible, with work in dusty atmospheres becoming extremely difficult or impossible. The rate at which a worker progresses to this stage, if at all, depends upon the amount of the causative agent contained in the dust inhaled, and the susceptibility of the individual.

In a study of American plants involving 995 workers, Braun et al.(*19*) came to the conclusion that prevalence of possible chronic effects could be as high as 14 percent in carders and 5.2 percent in other workers. Schrag and Gullett (*14*) studied textile workers in a large mill complex in the rural south. Of the 509 workers studied, 63 had byssinosis, a prevalence of 12%. Grade 3 byssinosis existed in 20 workers, of whom ten worked in carding, 4 in spinning, 4 in weaving, and 2 in picking operations. The prevalence of grade 3 byssinosis was much higher in those with more than 10 years of exposure to cotton dust.

El-Sadik et al. (*29*) in a study of lung function changes in different grades of byssinosis showed significant changes in FEV_1, vital capacity and other pulmonary function tests among grade 3 byssinotics. The authors pointed out that these changes are permanent in grade 3 byssinosis.

The clinical similarities between grade 3 byssinosis and other respiratory diseases have lead to misleading occupational mortality statistics, e.g. for heart disease (*73*) in which the final stages of grade 3 byssinosis create a strain on the heart leading to cardiac failure. That is to say that byssinosis, as a specific disease, is rarely reported as an underlying cause of death.

B. OTHER HEALTH EFFECTS

While byssinosis as a specific occupational disease is responsible for most of the symptoms in workers exposed to cotton dust, it seems clear that exposure to such dust also results in the production or exacerbation of respiratory symptoms characteristic of chronic lung disease of non-specific origin.

There is ample evidence that chronic bronchitis, (which is indistinguishable when produced by different etiologies), is far more common among cotton textile mill workers in cases where byssinosis symptoms are diagnosed by spirometry. (*31, 32, 17, 33, 34*) As with chronic bronchitis found in others, the condition may progress to the point of disability.

Elwood and co-workers (*33*) noted the presence of bronchitis as well as byssinosis in flax workers in Northern Ireland. They recognized two grades of byssinosis, differing largely in the persistence and quantity of production of phlegm from the chest. They observed that the similarity in the clinical pictures of advanced byssinosis and chronic bronchitis had been stressed by other writers. (*31, 32, 34*) A review (*20*) of the respiratory diseases of cotton workers showed that chronic bronchitis is frequently found in textile workers, specifically among those who have been diagnosed as byssinotic. Elwood et al. (*33*) suggested "that byssinosis represents an acute specific effect of certain textile dusts on the respiratory system, superimposed on a non-specific chronic bronchitic process." The clinical symptoms of the two diseases, as listed by Harris and associates, (*20*) are very similar.

Imbus and Suh (*18*) noted a marked relationship between the prevalence of byssinosis and bronchitis. Berry et al. (*41*) found the prevalence of bronchitis, unlike that of byssinosis, to be unrelated to dust levels. However, the prevalence of bronchitis among cotton mill workers was higher than in workers in synthetic fiber mills.

"Mill fever" is used to describe a symptom complex of unknown cause which occurs in some workers not accustomed to breathing cotton dust. (*20*) The symptoms which develop may include malaise, cough, fever, chills, and upper respiratory symptoms shortly after exposure. They disappear after acclimatization but may reappear after an absence from exposure or with an increased exposure to dust. (*35*)

Periodic outbreaks of an acute respiratory illness termed "weavers cough" have occurred among some workers. It appears as a sudden epidemic affecting both old and new workers. Earlier reports (*36, 37*) have associated its occurrence with mildewed yarn while other reports have incriminated tamarind seed powder, a constituent used in some yarn-sizing materials; unidentified sizing materials have been incriminated in other reports. Since weaver's cough is primarily associated with weaving operations where a low prevalence of byssinosis is expected, it appears that the occurrence of this illness among cotton workers depends upon unique situations involving mildewed yarns, sizing, or other unknown agents and not upon cotton dust as generally experienced by these workers.

Still another illness appears in workers handling dusty, (*39,40*) low-grade stained cotton. Those affected included cotton mill employees, workers at a cotton seed processing plant, and members of rural families using cotton to make mattresses. The illness, which began 1–6 hours after work started, had initial symptoms of fatigue and generaliezd aches, followed by anorexia, headache, nausea, vomiting, chills and fever. In these instances, symptoms ceased when respiratory protective devices were used or a better grade of cotton was substituted.

C. EARLY DETECTION PRIOR TO DEVELOPMENT OF CHRONIC DISEASE

Of critical importance to the regulation of exposure to cotton dust is the availability of techniques to detect susceptibility of workers prior to development of chronic disease. Cotton dust appears to be in the category of substances which produce discomfort or temporary physiological alteration prior to the development of irreversible disease. This fact makes early detection of byssinosis possible and therefore a critical element of an occupational health program.

Early detection of byssinosis historically has been achieved primarily by two methods, namely: the use of a questionnaire, and pulmonary function and reactivity testing.

1. *The use of a questionnaire.* A standard questionnaire such as the Medical Research Council (MRC) questionnaire (Appendix B), has been shown to be effective in identifying those individuals with the subjective symptoms of tightness in the chest. It has been argued that subjective symptoms may be exaggerated, understated, or coached by third parties. Although these arguments may have some degree of validity, the questionnaire survey technique has nevertheless been shown to be a valuable tool when used in a climate of mutual cooperation. In addition to the specific symtom of tightness, the questionnaire data reveal symptoms of bronchitis, e.g., chronic productive cough, and other symptoms of lung dysfunction such as shortness of breath (dyspnea), wheezing, and asthma.

Thus, medical questionnaires are considered valuable tools to indicate potential development or impairment, whether temporary or permanent. (*74*)

2. *Pulmonary function/reactivity testing.* Individuals who become sensitive to cotton dust and who are at increased risk of development of impairment, frequently show a temporary reduction of one or more pulmonary function measurements after exposure to cotton dust. While flow volume determinations and maximum mid-expiratory flow (FEF 25–75%) are considered to be the more sensitive measurements of reactivity, they have the disadvantages of non-specificity and greater

natural intra-subject variability. On the other hand, forced expiratory volume in one second (FEV_1), although less sensitive, appears less likely to respond to non-specific factors and shows less normal variation within subjects.

There is some evidence of the possibility of developing pulmonary impairment due to cotton dust exposure without previous evidence of subjective symptoms or abnormal pulmonary function. (*41, 42*) Imbus and Suh (*18*) found that exposed employees who do not exhibit subjective symptoms, are not at greater risk. However, Berry et al. (*41*) and Merchant (*42*) indicated that exposed employees show greater deterioration in pulmonary function, as compared with controls. The likelihood of pulmonary impairment occurring, however, is diminished by requiring that each employee have determinations of pulmonary function measurements periodically. These tests will ensure that any significant change from the baseline determination will become apparent before material impairment occurs. While this method does not guarantee that no non-symptomatic or non-reactive employees will remain undetected, it clearly minimizes the incidence.

D. INCREASED SUSCEPTIBILITY OF SOME WORKERS

Most epidemiological studies (*2, 14, 17, 24, 41*) reveal that some workers do not appear to be affected by very high dust exposures while others are affected at very low exposures. The reasons for these differences in susceptibility are not understood well, but seem to include cigarette smoking and previous state of health.

Byssinosis produces a chronic obstructive lung disease similar to that produced by other pollutants, such as cigarette smoke. Thus consideration must be given to the studies showing the increased risk of byssinosis among those cotton dust workers who are also cigarette smokers, and to acceleration of effects of byssinosis by cigarette smoking. (*44, 51*)

Merchant (*44*) et al. observed a 50–600 percent increase in the prevalence of byssinosis in male workers who smoke as distinct from workers who do not smoke. It is estimated that approximately two-thirds of male workers and one-third of female workers in the textile industry smoke cigarettes. Cigarette smoking is considered an additive risk factor in the development of byssinosis.

In addition, since the effects of exposure to cotton dust are related to chronic lung disease it is expected that the effects would be increased where there are pre-existing respiratory conditions.

Molyneux and Tombleson, (*66*) in a 1963–1966 study of respiratory symptoms in cotton mills, found a relationship between bronchitis and byssinosis. Merchant et al. (*17*) have noted that the workers who have bronchitis are more likely to have byssinosis than those without bronchitis.

III. PERTINENT LEGAL AUTHORITY

The primary purpose of the Act is to assure, so far as possible, safe and healthful working conditions for every working man and woman. One means prescribed by Congress to achieve this goal is the authority vested in the Secretary of Labor to set mandatory safety and health standards. The standards setting process under section 6 of the Act is an integral part of an occupational safety and health program in that the process permits the participation of interested parties in consideration of medical data, industrial processes and other factors relevant to the identification of hazards. Occupational safety and health standards provide notice of the requisite conduct or exposure level and provide a basis for ensuring the existence of safe and healthful workplaces.

The Act provides that:

> The Secretary, in promulgating standards dealing with toxic materials or harmful physical agents under this subsection, shall set the standard which most adequately assures to the extent feasible, on the basis of the best available evidence, that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life.
>
> Development of standards under this subsection shall be based upon research, demonstrations, experiments, and such other information as may be appropriate. In addition to the attainment of the highest degree of health and safety protection for the employee, other considerations shall be the latest available scientific data in the field, the feasibility of standards, and experience gained under this and other health and safety laws. [Section 6(b)(5)].

Section 2(b)(5) and (6), 20, 21, 22, and 24 of the Act reflect Congress' recognition that conclusive medical or scientific evidence including causative factors, epidemiological studies or dose response data may not exist for many toxic materials or harmful physical agents. Nevertheless, standards cannot be postponed because definitive medical or scientific evidence is not currently available. Indeed, while final standards are based on the best available evidence, the legislative history makes it clear that "it is not intended that the Secretary be paralyzed by debate surrounding diverse medical opinion." House Comm. On Education and Labor, H.R. Rep. No. 91–1291, 91st Cong., 2d Sess. 18 (1970).

This congressional judgment is supported by the courts which have reviewed standards promulgated under the Act. In sustaining the standard for occupational exposure to vinyl chloride (29 CFR 1910.1017), the U.S. Court of Appeals for the Second Circuit stated that "it remains the duty of the Secretary to act to protect the workingman, and to act even in circumstances where existing methodology or research is deficient". *Society of Plastics Industry, Inc* v. *Occupational Safety and Health Administration*, 509 F.2d 1301, 1308 (2d Cir. 1975), cert. denied 95 S. Ct. 1998, 44 L Ed. 2d 482 (1975).

A similar rationale was applied by the U.S. Court of Appeals for the District of Columbia Circuit in reviewing the asbestos standard (29 CFR 1910.1001).

The Court stated that:

> some of the questions involved in the promulgation of these standards are on the frontiers of scientific knowledge, and consequently as to them insufficient data is presently available to make a fully informed factual determination. Decision-making must in that circumstance depend to a greater extent upon policy judgments and less upon purely factual analysis.

[*Industrial Union Department, AFL–CIO* v. *Hodgson*, 499 F. 2d 467, 474 (D.C. Cir. 1974).]

In setting standards, the Secretary is expressly required to consider the feasibility of the proposed standards. Senate Comm. on Labor and Public Welfare, S. Rep. No. 91–1282, 91st Cong., 2d Sess., p. 58 (1970). Nevertheless, considerations of technological feasibility are not limited to devices already developed and in use. Standards may require improvements in existing technologies or require the development of new technology. *Society of Plastics Industry, Inc.* v. *Occupational Safety and Health Administration*, supra at 1309.

Where appropriate, the standards are required to include provisions for labels or other forms of warning to apprise employees of hazards, suitable protective equipment, control procedures, monitoring and measuring of employee exposure, employee access to the results of monitoring, and appropriate medical examinations. Moreover, where a standard prescribes medical examinations or other tests, they must be made available at no cost to the employees (section 6(b)(77)). Standards may also prescribe recordkeeping requirements where necessary or appropriate for enforcement of the Act or for developing information regarding occupational accidents and illnesses (section 8(c)).

IV. THE PROPOSAL

In the development of this proposal, OSHA has utilized extensively a number of scientific studies, including the *Criteria for a Recommended Standard—Occupational Exposure to Cotton Dust* developed by NIOSH.(*6*) Subsequent to the receipt of the NIOSH Criteria Document, OSHA has had extensive input from the scientific community, government, labor unions, affected industries, representatives of cotton growers, and equipment manufacturers.

The following section discusses the major elements of the proposed standard for occupational exposure to cotton dust and analyzes some of the significant issues raised. OSHA requests that comments and information be submitted on all the issues discussed or implicit in this preamble and proposed standard.

A. SCOPE AND APPLICATION

This proposed standard is applicable to all workplaces in all industries where exposure to cotton dust exists, including ginning, warehousing, compressing of cotton lint, classing and marketing of

cotton lint, fabric manufacturing using cotton yarn, reclaiming and marketing of textile manufacturing waste, delinting of cottonseed, marketing and converting of linters, reclaiming and marketing of gin motes and batting yarn felt manufacturing using waste cotton fibers and by-products. This standard also applies to industries in construction, maritime and agriculture, except harvesting, to the extent that exposure to cotton dust exists. The proposed standard does not apply to harvesting, because it is a distinctively farming operation and presents different exposure environments and possibilities of control than are proposed herein. Also, this standard would not be applicable to framing operations such as cotton ginning done on the farm, which employ 10 or fewer employees, until expiration of the appropriations rider discussed above. Nor does the proposed standard apply to dust generated solely from the handling of woven and knitted materials, such as dust generated during the manufacturing of garments from finished textile fabrics.

"Cotton dust" is defined as dust present in the atmosphere during the handling or processing of cotton. It may contain a mixture of many substances, including ground up plant matter, fiber, bacteria, fungi, soil, pesticides, noncotton plant matter and other contaminants, which may have accumulated with the cotton during the growing, harvesting, subsequent handling, processing or storage periods. Any dust present during the handling and processing of cotton through the weaving or knitting of fabric in textile mills, and dust present in other operations or manufacturing processes using new or waste cotton fibers or cotton fiber byproducts from textile mills, is considered cotton dust.

OSHA is aware that the majority of epidemiological evidence relates to the textile industry. OSHA is also aware, however, of evidence that health problems similar to those observed in the textile industry do exist in nontextile manufacturing industries which process cotton, and thus the scope of this proposal is not limited to the textile industry.

A recent study by Weill and Jones (*68*) of workers in cottonseed mills revealed a decline in ventilatory function of exposed workers. For several functional parameters the mean decline was significantly different from zero, from the expected change based on diurnal variation, and from the change on the last day of the work week. Both chronic bronchitis and acute byssinosis had a low prevalence among cottonseed mill workers, but the dust is apparently biologically active as evidenced by the bronchoconstrictor effects. Since an acute pulmonary constrictor response was evidenced, the authors suggested that the current dust levels in the cottonseed mills should be lowered.

NIOSH found, in a study of cotton ginworkers in Texas and New Mexico, that the prevalence of FEV_1 decrements was higher than the prevalence in the cotton textile industry itself. (*59*) These responses were more common and more severe in smokers, than in non-smokers. The reduced FEV_1 values in smokers were related to the number of years worked. Chronic respiratory disease was not related to any personal or area dust exposure level, probably due to the large variation in duties of the cotton gin worker over the years. Yet it appears that the same response pattern to cotton dust found in textile workers also was occurring in ginworkers.

An Australian study(*70*) of the cottonseed lint removal and crushing industry found high concentrations of dust ranging from 15 to 37 mg/m^3. Workers exposed to such concentrations showed a significant fall in FEV_1, whereas workers in the same plant not exposed to cotton dust were not affected. In a study of six cotton-garnetting plants in Australia, lung function tests of the machine operators showed an average decline in FEV_1 of 0.12 liter, with more than twice this decline in the most dusty areas.(*71*)

A British study of twenty-two mills representative of the waste cotton industry was undertaken in 1950.(*72*) Although the workers had never been exposed to any dust hazard other than waste cotton, disabling byssinosis occurred in 5 percent of the men, with 25 percent of the workers having lesser degrees of the same disease. Bronchitis or emphysema were found in an additional 11 percent of the exposed workers who had no indication of byssinosis.

In addition, the agency is aware that even within one industry, such as the textile industry, certain processes may generate dust of different composition and varying toxicity. OSHA has considered the suggestion that different standards based upon industry specific epidemiological evidence be established for the different industries involved and perhaps even for the varying processes within each particular industry. However, there is a lack of data indicating that exposure to cotton dust affects workers differently in the various affected industries, specifically, that workers react in a manner dissimilar to that of the textile workers. Indeed, the evidence which is available supports the view that exposure to cotton dust, regardless of the stage of processing in which the dust is encountered, results in byssinosis and other respiratory diseases. It is OSHA's view that the need to protect workers in all industries utilizing cotton outweighs the constraints upon regulatory action which might be advocated because of the fact that much of the epidemiological data has arisen from one segment of the cotton industry. OSHA invites comments and testimony concerning the scope of this cotton dust standard.

B. PERMISSIBLE EXPOSURE LIMIT

1. *General considerations.* Considerations involved in setting a permissible exposure limit for cotton dust are more complicated than those in setting a standard for a single chemical or physical agent. As noted, cotton dust may contain a mixture of many substances(*45, 46, 69*) including ground up plant material, fiber, bacteria, fungi, soil, pesticides, non-cotton plant material and other contaminants. The relative proportion of these substances in the "cotton dust" at any time can vary depending upon the type of plant, harvesting and storage methods, and cleaning operations, both at the gin and in subsequent processing. The causative agent(s) of byssinosis are not known. Various theories have been advanced, including that the causative agent in the cotton dust is one or more chemical toxins(*47*) contained in the plant material, a histamine releasing agent,(*48, 49*) bacterial enzymes,(*50*) an antibody producing agent, (*51, 52*) or bracteria.(*53, 45*)

Since the causative agents are not known and since the composition of cotton dust can and does vary, it is reasonable to expect variation in the proportionate amounts of causative agents in various types of cotton dust. Nevertheless, despite these anticipated but as yet unspecified variations, the evidence available clearly indicates that exposure to cotton dust, wherever it occurs, is a health hazard.

A correlation between cotton dust concentrations and the prevalence of byssinosis has been found by most investigators who have studied the effects of exposure of workers to cotton dust. (*1, 19, 30, 51, 55, 57, 58*). However, the dose response relationships obtained by different investigators vary considerably. One or more of the following factors may explain some of these differences in prevalence of byssinosis observed by investigators at comparable dust levels:

(a) *Observer differences.* Prevalence of byssinosis has been based in part upon questionnaire responses. Therefore, there is the possibility of different interpretations of questionnaire responses by different observers, leading to varying diagnoses.

(b) *Difference in worker response to questions.* Braun (*19*) has pointed out the lack of uniformity of questionnaire responses when administered to the same individuals at different times. Questions may be given different interpretations by workers in various regions (linguistic difficulties may compound this); (*59*) some workers may tend to minimize, while others may exaggerate, symptoms.

(c) *Length of exposure.* Some studies have correlated prevalence of byssinosis with years of exposure per given dust level; others have not. An employee population with relatively brief exposure may be associated with lower prevalence at given dust levels.

(d) *Previous exposure history.* Some workers may have been previously exposed to very high dust concentrations making them very reactive to lower dust levels, even after environmental conditions are controlled.

(e) *Different toxicity of dust.* Dust generated by different processes, such as carding versus spinning, may have different toxicity. (*55, 56*) Weaving dust often contains considerable amounts of sizing material, such as starch or polyvinyl alcohol, which has been added to

the fiber to aid further processing. Cotton grown in different regions may have variable amounts of microorganisms, and presumably different proportions of plant and extraneous material. Cotton blend mills may have significant amounts of synthetic particles in the dust samples.

In summary, despite these differences, a correlation between cotton dust concentration and the prevalence of byssinosis has been found by most investigators who have studied the effects of exposure on cotton workers. (*6*)

2. *Permissible exposure limit.* The proposed standard sets a permissible exposure limit of 200 micrograms of vertical elutriated cotton dust per cubic meter of air average over an eight hour work shift. In arriving at this level, consideration was given to many different recommendations presented in the literature, particularly the recommendations of NIOSH as expressed in the criteria document and subsequent memoranda.

In general, most research demonstrates a decrease in disease prevalence with decrease in dust levels. In addition, although some variation exists among investigators, especially in the area of relation of exposure to clinical effects and to the development of chronic disease, it appears that exposure to cotton dust is clearly harmful over a wide range of exposures, and, in fact, recent studies show a higher prevalence of byssinosis at even lower dust levels than evidenced by earlier studies.

Roach and Schilling (*1*), in the 1950's, the first to conduct extensive studies in British textile mills of the relationship of dust levels to the prevalence of byssinosis, found "virtually no byssinosis" where total dust concentrations were below 1000 ug/m³. Subsequently, in 1970 Roach (*54*) noted a 1.5 percent prevalence at concentrations of fly-free dust below 500 ug/m³. He therefore suggested that less than 400 ug/m³ be considered "negligible" and that concentrations between 500 and 1400 ug/m³ fly-free dust be considered low, producing an estimated risk of less than 2 percent of those exposed developing chronic impairment (Grade 3 byssinosis). The British Occupational Hygiene Society appeared to be in general agreement with Roach, when, in 1972, its Subcommittee on Vegetable Textile Dust recommended that dust levels of 500 ug/m³ be categorized as "low."

Merchant, (*51*) et al. however, in his studies of textile mills in the U.S., reached the conclusion that 500 ug/m³ would result in a 25 percent prevalence of all grades of byssinosis. The investigators, using the vertical elutriator, found a strong linear association between the prevalence of byssinosis and the concentration of lint-free dust (less than an aerodynamic equivalent diameter of 15 microns). In cotton preparation and yarn areas, untreated cotton was shown to produce 3 percent byssinosis (all grades) at 50 ug/m³, 7 percent at 100 ug/m³, and 13 percent at 200 ug/m³. These findings were in general agreement with the findings of Molyneux and Tombleson. (*66*)

Imbus and Suh, (*18*) in a 1973 study of the biological effects of cotton dust on workers, also showed significant prevalence of byssinosis at low levels of exposure. At concentrations below 250 ug/m³, the prevalence ranged from 13.5 percent in preparation areas to 3.5 percent in yarn areas, with 5.7 percent in both preparation and yarn areas.

NIOSH initially did not recommend a specific exposure limit in its criteria document, rather, the document was primarily directed toward medical screening, work practices, respiratory protection, and administrative controls. However, it recommended that engineering controls be implemented and that an environmental standard be set at the lowest level feasible. Later modification of the criteria document posited a level "in no case as high as 200 ug lint-free cotton dust/m³" as being the "lowest feasible limit."

In determining how best to regulate employee exposure, OSHA has considered options ranging from no environmental limit to a specified environmental level ranging from 1000 $\mu g/m^3$ total dust to 100 $\mu g/m^3$ respirable dust as follows:

(A) *No permissible exposure limit.* OSHA has considered setting a standard for cotton dust without defining a specific permissible exposure limit. Reliance would be primarily upon medical screening, work practices, respirators, and administrative means.

However, OSHA believes that this option places too great a reliance on the use of respirators, and places too many workers at risk. It also does not provide suitable incentive for the institution of engineering controls, which are considered to be the most appropriate form of long term protection against chronic disease.

(B) *Options which include a permissible exposure limit.* In setting a permissible exposure limit, there are a variety of options. Those options which appear to be the most reasonable are discussed below.

(i) A different permissible exposure limit for different industries and processes. Ideally this may offer the most precise method of establishing the lowest feasible level for each affected industry. However, because data are not available with which to scientifically set different limits, OSHA believes that this option is not feasible. In addition, variation in the hazard appears to depend upon many factors other than process.

(ii) A permissible exposure limit of 1000 ug/m³ total airborne dust. This is the current OSHA standard and is based upon the original ACGIH threshold limit value of 1966. However, in the past few years, even the proponents of this level have proposed standards based upon fine or respirable dust. It has been found that observed health effects are poorly related to measured total dust concentrations. OSHA is of the view that a permissible exposure limit based upon total dust would not adequately reflect the potential of the dust to adversely affect health.

(iii) Permissible exposure limit of 500 ug/m³ respirable dust. Some investigators have shown a "low" prevalence of byssinosis, generally less than 10 percent (all grades) and less than two percent grade 2, following exposure at estimated dust concentration levels of 500 ug/m³ respirable dust. (*6, 54, 55*) It appears that 500 ug/m³ respirable dust (as measured by the vertical elutriator) is roughly equivalent to 1000 ug/m³ total dust, a level viewed as inadequate in the above discussion.

Merchant concludes that 500 ug/m³ respirable dust would result in a prevalence of byssinosis of over 25 percent (all grades). Therefore, though 500 ug/m³ may be somewhat protective in a number of cotton processing operations, OSHA considers the work of Merchant and others as indicating that it is not sufficiently protective in many operations.

(iv) Permissible exposure limit of 200 ug/m³ respirable dust. As previously discussed, the American Conference of Governmental Industrial Hygienists, while recognizing that there was no readily measurable limit that would eliminate byssinosis, in 1974 established a Threshold Limit Value for cotton dust of 200 ug/m³ of dust composed of fibers less than 15 um. According to the work of Merchant,(*51*) there would be a predicted prevalence of byssinosis of 12.7 percent (all grades) and 3 percent (Grade two) at 200 ug/m³; other investigators(*54, 55, 60*) have found lower prevalence at these levels, but nevertheless conclude that some byssinosis will exist.

(v) A permissible exposure limit of 100 ug/m³ respirable dust. This level, proposed by Merchant(*51*) and others,(*62*) represents the safest limit of all the proposals considered. This does not mean, however, that even at this level no adverse health affects will be seen in the case of the susceptible worker. A permissible exposure limit of 100 ug/m³ is considered by OSHA, based on the available evidence in the technological feasibility assessment and elsewhere, to be extremely difficult to implement, if not totally infeasible in many operations covered by this standard. In addition, because background air contamination in a number of industrial locations approaches this suggested level,(*6*) it creates difficulties due to interference by particulate matter from other sources. The question has also been raised as to the accuracy and difficulty of sampling methods at this level. NIOSH(*6*) concludes: "The feasibility of achieving a level of 100 ug/m³ as measured by the vertical elutriator in the operating areas of opening, picking, carding, drawing, and combing is not now evident using commercially available dust removal equipment."

(c) *The Proposed Permissible Exposure Limit.* The proposal contains a permissible exposure limit of 200 ug/m³ of vertical elutriated cotton dust averaged over an eight-hour work shift. OSHA believes that much of the data would provide strong justification for a 200 ug standard. Based upon its own evaluation of the

studies, the ACGIH has established a Threshold Limit Value of 200 ug/m³ of the respirable fraction of cotton dust.

In the criteria document, NIOSH stated that there is "no environmental limit of cotton dust that will prevent all adverse effects on workers health." Merchant et. al. found cases of byssinosis associated with dust levels as low as 50 ug/m³. (*51*) Statistical treatment of the data of Molyneux and Berry, (*55*) and Imbus (*18*) and Suh, indicates some prevalence of byssinosis at exposure levels so low as to be effectively zero. These data cannot be ignored. Accordingly, OSHA recognizes the absence of any known "safe level of exposure." When it proposes a permissible exposure limit of 200 ug/m³ of respirable cotton dust, which it considers to be the "lowest feasible," OSHA feels that considerable reduction of work place exposure accompanied by a substantial decrease in byssinosis, particularly the chronic variety, can be achieved at this level.

Although OSHA's first and prime responsibility is to assure employees safe and healthful places of employment, the Act and its legislative history recognize that feasibility is a legitimate factor to be considered in the setting of occupational safety and health standards. In setting standards for which no safe level of exposure can be shown, such as cotton dust, OSHA's policy has been to set the standard at the lowest level feasible.

Even though the limit of 100 ug/m³ recommended by Merchant et. al. does not provide, according to their data, complete protection against the symptoms of byssinosis, it is so low that background dust levels in some cases could interfere with accurate determinations of cotton dust levels and with attainment of the required dust level. Implementation of this or lower levels would appear to require efficient filtration of outside makeup air entering the ventilation system in many areas. (*63, 76*) In addition, a survey of the technological capabilities of the industry at this time and during the foreseeable future indicates that a level of 100 ug/m³ is not likely to be feasible. (*77*)

Therefore, on the basis of all the currently available evidence, 200 μg/m³ of respirable cotton dust appears to represent the lowest feasible level, and to provide substantial protection for employees exposed to cotton dust.

The proposed standard would require implementation of medical surveillance, monitoring, employee training, and the like in any place where cotton dust is present. Thus, where a permissible exposure level is not a "safe" level but rather a level predicated largely upon feasibility, caution requires the exercise of certain protective measures if there is any exposure to the substance.

OSHA is aware of gaps which exist in the data, and intends to review its estimate of feasibility and other factors relevant to setting a cotton dust exposure limit if warranted by additional evidence presented in the rulemaking process.

(c) *Methods of exposure measurement.* 1. *Sampling devices.* Cotton dust ranges in size from particles large enough to be visible to the naked eye to those which are submicron in size. The shape of the particles is also irregular. Therefore, particle size is equated with the "aerodynamic equivalent diameter," i.e. the size of a unit density sphere having the same settling velocity as the particle in question, of whatever size, shape or density. Most investigators (*41, 51, 66*) currentlyy agree that a better correlation exists between respirable dust and health effects, since total dust measurements include a significant fraction of particles which are too large to be deposited in the respiratory tract. Medical and environmental evidence presently favors the use of a permissible exposure limit based upon respirable dust. Many of the more recent studies have involved the use of the vertical elutriator for measuring employee exposure to cotton dust. While this method collects somewhat more than the respirable fraction, including particles up to approximately 15 microns in size, exposure data derived from the use of the vertical elutriator have generally been shown to correlate well with indicators of biological response.

The vertical elutriator utilizes the principle that particles with settling velocities less than the velocity of an air stream will be carried upward by a stream of air in a cylinder. The flow rate of 7.4 liters/minute is required to achieve cut off size at 15 um. The larger particles, with settling velocities greater than that of the vertical air stream, will settle out during their course of upward motion and will not be measured, whereas the smaller particles reach the top and are collected on a filter.

The vertical elutriator as discussed above is described by Lynch.(*64*) Its use in the field, both for research and periodic monitoring purposes, has been accepted. The vertical elutriator, including pump, is approximately three feet in height, 6 inches in diameter and weighs approximately 15 lbs.; therefore, its use at its current stage of development requires fixed sampling sites.

Determining exposure to cotton dust in a large plant may require many samples. Since several hours are required for each sample, it is obvious that to complete the sampling in several days, a number of units must be used simultaneously. Some other problems in using the vertical elutriator are: the necessity of relatively regular maintenance for its motors; the time consumed in the process of pre- and post-sample weighing of filters; the difficulty of calibration and maintaining calibrated flow rates; and, because of their size, the number of samplers susceptible to damage during transportation.(*65*)

Other sampling devices have been tested and utilized for collecting respirable cotton dust. One that has offered some promise is the GCA dust collector with miniature vertical elutriator attachment, as reported by Neefus.(*65*) This device utilizes the principle of a radioactive source to determine the amount of impacted dust. At higher dust levels (generally above 700 ug/m³), its correlation with the vertical elutriator results is erratic.

The use of the horizontal elutriator and Hexhlet was also reported by some investigators. (*1, 17, 63*) Lumsden (*17*) has described a cyclone apparatus attached to a high volume sampler; however, this is even more bulky, expensive, and complicated than the vertical elutriator. OSHA invites comments on the present state of the art of samplers capable of size-selective sampling of cotton dust.

In view of several important advantages of the vertical elutriator; its availability, extensive experience with its use, proven reliability and, most importantly, its ability to monitor exposure to respirable dust, the proposal requires the use of the vertical elutriator in accordance with Appendix A, "Air Sampling and Analytical Procedures for Determining Concentrations of Cotton Dust," for conducting the required monitoring.

2. *Personal Versus Area Sampling.* There are definite advantage in relating a dust concentration measurement to a particular employee's exposure. Thus, wherever possible, OSHA has considered the use of personal sampling devices that can be worn by an employee through the working day to be superior to area samplers even though OSHA recognizes the use of area sampling for periodic environmental monitoring. Presently, OSHA is using a personal sampler consisting of a portable pump to which an open face filter is attached by means of flexible tubing. The filter is then attached to the employee's lapel or collar. Though OSHA has considered this method more representative of employee exposure, it does present certain disadvantages. It is prone to contamination with fiber and large dust particles due to actual contact of the employee with cotton lint that gathers on the employee's clothing. Likewise, undue agitation of the filter may result in loss of the sample. Wide variation of cotton dust concentrations for workers performing similar jobs in the same area have been reported using this method. While some of this variation may be attributable to varying work activities, it is possible that much of it may be due to the collection method itself. Ideally, a small device which could be attached to individual employees and which would collect only smaller particles would be more suitable. Such a device should not be unduly influenced by the continuing motion of the employee. Some work has recently been done in developing a portable vertical elutriator. However, flow rates for such a small device are quite low and unless dust concentrations are high, it must be worn for an impractically long period of time in order to collect an adequate sample. Also, the potential problem of variability of results due to agitation of air currents from motion of the employee has not been fully evaluated.

Since data presently available indicate the desirability of basing a standard upon respirable dust, OSHA considers it

appropriate to base its permissible exposure limit upon that fraction of dust with an aerodynamic equivalent diameter of approximately 15 microns or less. Currently there is no satisfactory method known to OSHA of collecting such a dust fraction with a personal type sampler. Thus area sampling with a vertical elutriator is proposed. Area sampling has long been used by industrial hygienists and if properly conducted to reflect breathing zone levels of contaminants, can, together with accurate estimates of employee activity, reasonably assign dust exposure to particular employees.

Due to the difficulties of cotton dust sampling, the proposal requires a specific monitoring protocol, as stated in Appendix A, "Air Sampling and Analytical Procedures for Determining Concentrations of Cotton Dust."

D. *Exposure monitoring program.* Under the provisions of the proposal, employers would be required to make measurements in all places of employment in which cotton dust is present.

The measurements are required to be representative of all employees' exposure to cotton dust. Measurements must be taken for each job classification in each shift regardless of concentration, and must be repeated at least every 6 months and whenever there is a change in work practices, process, or control methods likely to result in an increase in employee exposure to cotton dust.

The employer must notify all employees of the exposure measurements which are representative of their exposure and if an employee's exposure is above the permissible exposure limit he shall be informed of the corrective action being taken.

E. *Methods of compliance.* Compliance with the proposed standard of 200 ug/m³ presents unique problems. From evidence currently available, it appears that most affected industries are unable to comply immediately with OSHA's traditional priority of control methods which requires that the permissible exposure level be achieved by means of engineering controls. Accordingly, this proposal would phase in, over a period of 7 years, the requirement to reach the permissible exposure limit solely by engineering controls, while requiring the immediate achievement of that level through the use of respirators, as set out below.

The proposed standard would require that employers immediately institute feasible engineering controls to reduce employee exposure to cotton dust to no more than 500 ug/m³ vertical elutriated cotton dust. The permissible exposure limit of 200 ug/m³ would be achieved by means of supplementary and respiratory protection controls. Further reduction to 350 ug/m solely by means of engineering controls would be required within 4 years from the effective date of this standard. Again the permissible exposure limit of 200 ug/m³ would be achieved by means of supplementary respiratory protection controls.

Finally, a reduction to the permissible exposure limit of 200 ug/m³ solely by means of engineering controls would be required within 7 years from the effective date of this standard.

The employer would be required to develop a written plan and to implement a program in accordance with that plan to reduce exposures solely by means of engineering and work practice controls as required by the above schedule.

OSHA's first and prime responsibility is to assure employees safe and healthful places of employment. The Act and its legislative history however recognize that feasibility is a legitimate factor to be considered in the setting of occupational safety and health standards. The information gathered on the issue of technological feasibility suggests great difficulties in immediately achieving the proposed level solely by means of engineering and work practice controls. Based upon this information, it appears that reduction of exposures to 350 ug/m³ solely by means of engineering and work practices controls, in cotton yarn production, could not be achieved in less than 4 to 5 years; and that achieving compliance with the exposure level of 200 ug/m³ solely by means of such controls would take considerably longer, perhaps 8 years or more. Implementation time for the other industry sectors, such as ginning, weaving, and waste processing, is more difficult to assess. A reduction of exposure to 500 ug/m³ may be attainable with existing control devices, but below that level several years would be necessary for design, manufacture and installation of the required controls in many affected establishments. (*76, 77*)

The primary determinant of these time estimates is the ability of the regulated industry to design, produce, and install equipment that will reliably produce the required level of control. At best, a typical yarn mill may require 18 to 24 months for the steps involved, from the preliminary planning to specifications, contracting, delivery, installation, testing, and full operation of engineering controls.

The technological restraints, illustrated by this discussion, on achieving the degree of dust control required, solely by means of engineering and work practice controls, indicate that it is virtually impossible to achieve a level of 200 $\mu g/m^3$ solely by these means, in less than several years. Accordingly, the proposed cotton dust standard includes a schedule for the primary purpose of establishing the maximum time periods in which employers will be allowed to achieve the permissible exposure level solely by means of engineering and work practice controls. However, the proposal requires that where the permissible exposure level of 200 $\mu g/m^3$ cannot be accomplished immediately by engineering controls that supplementary respiratory protection controls shall be used to reduce exposures to this level.

F. *Use of respirators.* Respirators are generally the least satisfactory means of exposure control because they are capable of providing good protection only if properly selected, properly fitted, worn by the employee, and replaced when they cease to provide adequate protection. While it is possible for all of these conditions to be met, often they are not. Consequently, the protection of employees by respirators is not as effective as the protection provided by engineering controls which eliminate or reduce the dust at the source. Further, employees with impaired respiratory function may not be able to wear certain types of respirators, such as those operating in the negative pressure mode.

Despite the inherent difficulties associated with respirator use, they remain the only viable form of protection when engineering and work practice controls cannot reduce exposure below the permissible limit. The proposed standard requires the use of respirators to control employee exposure to the permissible exposure limit of 200 ug/m³. As specified under the methods of compliance section, respirators would be used as a supplement to work practice and engineering controls. The proposal would require the employer to select respirators specified in the table and tested and approved by NIOSH.

The proposed standard provides that, where respirators are required for concentrations not greater than 10,000 ug/m³, the employer shall provide a powered air purifying respirator for each affected employee who expresses a preference for such a device. The wearing of a non-powered respirator may be difficult for medical reasons, e.g., reduced pulmonary function or chronic lung disease. The significant prevalence of such conditions among employees exposed to cotton dust and the extent of initial reliance on respirators to achieve the required exposure reduction suggest that there will be numerous employees who would find it difficult to wear respirators of a negative pressure or demand type. Since there are no objective medical tests to determine an employee's ability to wear a nonpowered respirator, the determination must be left to the subjective evaluation of the employee.

G. *Work practices.* OSHA recognizes that in most processes in which cotton dust is present, even exposures below the permissible exposure level may be harmful, as there is no "safe" level of exposure. Therefore, definite work practices and procedures must be instituted to control employee exposure.

These work practices must be continued even after the permissible exposure level is attained.

The proposal requires that several work practices be implemented including the proper maintenance of exhaust systems; the elimination of employee "handling" of cotton except where the employer shows that it is infeasible to perform a particular job by mechanical means; prohibition of "blow downs" except where alternatives are not available; and other practices designed to minimize the dispersal of airborne dust.

H. *Medical surveillance procedures.* The proposed standard requires each employer to institute a medical surveillance program for all employees exposed to cotton dust. The role of medical surveillance in protecting the health of employees exposed to cotton dust has been widely recognized by many investigators.

The NIOSH criteria document provided recommendations for a medical surveillance program. Section 6(b)(7) of the Act provides the authority to include medical surveillance in an OSHA standard. The Act states:

> • • • where appropriate any such standard [promugated under subsection 6(b)] shall prescribe the type and frequency of medical examinations or other tests which shall be made available, by the employer or at his cost, to employees exposed to such hazards in order to most effectively determine whether the health of such employees is adversely affected by such exposure

The proposed standard requires that the medical surveillance program provide each affected employe with an opportunity for medical examination. All examinations and procedures are required to be performed by or under the supervision of a licensed physician and provided without cost to the employee. While a licensed physician is clearly the appropriate person to be conducting a medical examination, certain aspects of the medical surveillance program, e.g., the questionnarie and pulmonary function tests, do not necessarily require the physician's expertise and may be conducted by another person under the supervision of the physician. Of concern to OSHA is the quality of training of the persons administering the questionnaire and conducting pulmonary function tests. At the time of this proposal, there is no approved and generally recognized source of training for pulmonary function technicians. OSHA is seeking specific suggestions for inclusion in the standard of criteria by which an employer can determine which persons are competent to conduct these tests. Additionally, OSHA has requested NIOSH to provide specifications for appropriate procedures and equipment to be used in performing pulmonary function evaluations for this and certain other health standards.

The proposed standard provides that a standardized respiratory questionnaire (Appendix B) and pulmonary function measurements including FVC and FEV_1 be performed at the time of initial assignment or upon institution of the medical surveillance program. The purposes of this requirement are to make an initial assessement of the fitness of each employee to be exposed to cotton dust and to establish a baseline health condition against which changes in an employee's health may be compared. The pulmonary function measurements are required to be performed before the employee enters the workplace on the first day of the working week, following a period of at least 35 hours away from work. The test will be repeated following exposure of no less than 4 hours and no more than 10 hours, but in any event no more than 1 hour after cessation of exposure. A determination will be made of the amount of FEV_1, the FVC and the percentage that the measured values of FEV, and FVC differ from predicted values using the standardized tables in Appendix C. The regulation specifies the formula to be used for applying the tables to results obtained in whites and blacks. OSHA requests information on formulas which should be used for evaluating results of pulmonary function among other ethnic groups.

FEF 25–75 percent has been considered for inclusion since at low lung volume it may be a more sensitive early indicator of airway obstruction than FEV_1. No. additional breathing maneuvers by the workers or new apparatus for pulmonary function testing are necessary, only the slight additional training of the technician to make this calculation from the forced expiratory curve. OSHA solicits information and views concerning whether FEF 25–57 percent should be required.

Each employee will be classified based upon questionnaire results as to whether or not he exhibits symptoms of byssinosis using the Schilling classification, and whether or not he exhibits the pulmonary function reactor state. The latter will be based upon a determination as to whether there is a decrease in FEV_1 of either 5 percent or 200 ml, whichever is less, from the beginning of work shift to the time of retesting. Employees will be retested on at least an annual basis. The FEV_1 and FVC will be compared with the baseline established on the original testing and a determination will be made on an annual basis of whether there has been a significant decrease of FEV_1 or FVC. Where in the opinion of a physician, or health professional under the supervision of a physician, a significant change in questionnaire findings or pulmonary function results has occurred, the employee will be so advised, and portions of the medical surveillance will be performed with increased frequency.

The employer is required to provide the physician with certain information. This information includes a copy of the regulation, a description of the affected employee's duties as they relate to the employee's exposure, the results of the employee's exposure measurement, if any, or the employee's anticipated or estimated exposure level, a description of any personal protective equipment used or to be used, and information from previous medical examinations of the affected employee to the extent that they are not readily available to the physician. The purpose in making this information available to the physician is to aid in the evaluation of the employee's fitness to work in the regulated area and fitness to wear personal protective equipment.

The employer is required to obtain a written opinion from the examining physician containing: the physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of health from exposure to cotton dust; the results of the medical examination; recommended limitations upon the employee's exposure to cotton dust and upon the use of respirators; a statement that the employee has been informed by the physician of any medical conditions which require further examination or treatment.

The proposed standard also contains a procedure to be followed by the employer in the event that an employee refuses to undergo any required examination. This procedure involves informing the employee of the potential risks that are incurred by a refusal to be tested or medically examined, and obtaining from the employee a signed statement attesting to the fact that the employee fully understands the potential risk, but still does not wish to be tested or examined. It is not the intent of OSHA to encourage employees to avoid medical examination or testing. On the contrary, OSHA believes that the positive action taken by employers to inform employees of the risks involved will encourage employees to undergo the examinations.

The proposed standard does not include a provision prohibiting the exposure of an employee to cotton dust if the employee would be placed at increased risk of material impairment of his or her health from such exposure. Nor does the proposal include any provision requiring the transfer of such an employee to another job, or that removal for medical reasons would not result in loss of earnings or seniority status to the affected employee. Provisions of this type have been referred to collectively as rate retention and mandatory removal.

The Coke Oven Emission standard (41 FR 46742 at page 46780, October 22, 1976) addresses the major considerations which must be dealt with in determining how to treat this issue. The conclusion reached by OSHA in that document is that.

> • • • further exploration of this (the rate retention) issue is necessary in order to deal in considerably more depth with the numerous issues raised by such a provision. It is therefore our intention to conduct further study, through an Advisory Committee or other means, of the need and implications of rate retention as an aspect of an OSHA health standard. On the basis of this study, the Agency will take further action under the Act, as appropriate, regarding rate retention.

In the meantime, with respect to the cotton dust proposal, OSHA specifically invites comment on the issues related to the propriety, scope and implications of a rate retention requirement in this standard, including: the number of employees who would be at increased risk from exposure to cotton dust at levels below 200 ug/m³; the range of rate retention provisions available and their relative merits; pertinent medical information related to determining when a condition is caused by agents other than cotton dust, e.g. a pre-existing respiratory condition, and, if so, whether an employer should be responsible for such an employee's retention of pay rate where said condition results in transfer or mandatory removal; the impact of such a provision on the affected industries, including the impact on collective bargaining; and possible alternatives to employee withdrawal.

The unique aspects of cotton dust exposure which make treatment of this issue so complex, are (a) the number of employees who are presently known to suffer from byssinosis and other res-

piratory conditions and, (b) the uncertain number of employees projected to be reactive even at levels below 200 ug/m³. The existence of such employees, coupled with the fact that the industries involved do not seem to present a significant number of non-exposure job positions, make this a particularly difficult matter in this proposal.

I. *Employee Education and Training.* Information and training are essential for the protection of employees, because employees can do much to protect themselves if they are informed of the nature of the hazards in the workplace. To be effective, however, an employee education system must apprise the employee of the specific hazards associated with the work environment. For this reason the employer is required to inform each employee who is assigned to work in the presence of cotton dust of the specific nature of operations which result in cotton dust exposures.

The proposal requires that employees be trained in proper procedures to avoid unnecessary exposure. In addition, the proposal requires that employers provide a training program which shall, among other things, advise employees of the signs and symptoms of exposure to cotton dust and the purpose, proper use, and limitation of respirators. In addition to these training and education requirements, appropriate signs must be posted wherever employees are required to wear respirators.

J. *Recordkeeping.* Section 8(c) of the Act requires that each employer shall keep and make available such records as the Secretary may prescribe as necessary or appropriate for the enforcement of this Act, or for developing information regarding occupational accidents and illnesses. The proposal would require employers to maintain written records of the following: (1) All exposure measurements; and (2) medical surveillance.

Because symptoms of disease that may be related to exposure to cotton dust may not appear for several years following an initial exposure the proposal requires that records of employee exposure measurements and medical examinations be retained for at least 20 years to aid in fulfilling the Secretary's obligations under the Act.

The proposal's recordkeeping provisions also require that the aforementioned records be made available for examination and copying to the Secretary, the Director of NIOSH, employees, former employees or their designated representatives.

K. *Observation of monitoring.* Section 8(c)(3) of the Act requires that employers provide employees or their representatives with the opportunity to observe the monitoring of exposures to toxic materials or harmful physical agents. In accordance with this section, the proposed standard contains a provision for such observations. To ensure that this right is meaningful, observers would be entitled to an explanation of the measurement procedure, to observe all steps related to it, and to record the results obtained.

The observer, whether an employee or a designated representative, must be provided with, and is required to use, any protective devices required to be worn by employees working in the area that is being monitored and must comply with all other applicable safety and health procedures.

V. Conclusions

OSHA recognizes that many of the matters considered in this proposal are controversial and that gaps exist in the available scientific evidence. OSHA believes, however, that in this case we are dealing with an agent or agents that are extremely harmful to man. The existence of unanswered questions cannot be permitted to delay the process of proposing a standard for protecting workers exposed to cotton dust, as tens of thousands of workers are believed to suffer from the effects of exposure. OSHA hopes that the public participation which is invited will help to fill whatever gaps exist.

Therefore, based upon the available evidence and in view of the above considerations, OSHA believes that employee exposures to cotton dust must be reduced to the level of 200 ug/m³ of vertical elutriated particulates and that the other requirements to regulate exposure to cotton dust must be imposed, as set forth in the proposal. After the conclusion of the public rulemaking which follows, OSHA will evaluate all evidence received and issue a final standard based on the entire record.

VI. Technological Feasibility Assessment and Economic and Inflationary Impact Statement

Pursuant to section 6(b) of the Occupational Safety and Health Act and in accordance with Executive Order No. 11821 (39 FR 41501, November 29, 1974), OMB Circular A-107 (January 28, 1975), and Secretary's Order No. 15-75 (40 FR 54484, November 24, 1975), OSHA contracted for and received a technological feasibility assessment and economic and inflationary impact statement from Research Triangle Institute. The statement was reviewed in accordance with the criteria specified in section 5(c) of the Secretary's Order, and OSHA concluded that the proposed regulations of cotton dust is a "major" action and so certified pursuant to section 4(b) of the Secretary's Order, on September 2, 1976.

This certification was reviewed by the Assistant Secretary of Labor for Policy, Evaluation, and Research. Pursuant to section 4(b) of Secretary's Order No. 15-75, concurrence was granted on September 7, 1976.

This statement along with all other references cited and other relevant material, are available for inspection and copying at the OSHA Technical Data Center, Room N-3620, 200 Constitution Avenue, NW, Washington, D.C. 20210. OSHA invites comments on any of the information contained and conclusions drawn in said statement concerning technological feasibility and economic and inflationary impact.

VII. Environmental Impact

The preceding description of the proposed standard and its rationale, as well as the following sections on environmental impact, constitute OSHA's draft environmental impact statement on the proposed standard for occupational exposure to cotton dust.

This statement has been prepared in accordance with the requirements of 29 CFR Part 1999 (OSHA's regulations for the preparation the Guidelines of the CFR Part 1500, pursuant to the provisions of the National Environmental Policy Act (Pub. L. 91-120, 42 U.S.C. 4321 et. seq.) and Executive Order No. 11514. The purpose of this draft environmental impact statement is an aid to Agency decision-making on proposed actions which may have the potential for significantly affecting the quality of the human environment. Written comments and information on the projected impacts of this proposed standard for exposure to cotton dust are solicited from any interested persons or groups during the period for written comment submissions listed below in this Notice.

In addition to this general request for comment, copies of this proposal and environmental impact statement have been sent to numerous Federal and State agencies, industry representatives, employee unions, and public interest groups with requests for their comments. A copy of this listing is available in the OSHA Technical Data Center, Room N-3620, Department of Labor, 200 Constitution Avenue, NW, Washington, D.C. 20210.

Testimony, data, arguments etc. may also be addressed at the public hearing to be held on this proposed standard April 5, 1977, provided pre-hearing submission requirements, also outlined below, are complied with.

Additional copies of this proposed standard and draft environmental impact statement are available for review and copying in the OSHA Technical Data Center.

Standards promulgated by OSHA have the potential for impact on two environments. The most significant impacts will occur to the workplace environment, while lesser impacts occur to the general human environment external to the workplace.

The first five sections of this preamble to a proposed standard for occupational exposure to cotton dust outline the requirements of the proposal and the impacts to be expected as a result of its implementation. Generally, the impacts on the workplace environment are expected to be beneficial ones, including: fewer cases of byssinosis, fewer cases of dust-induced respiratory symptoms, fewer lost workdays due to dust-induced illness, etc. The preamble details the studies and reports on which OSHA bases its assumption that these beneficial impacts will occur. Further, it is anticipated that more information concerning the proposal's potential for impacting the workplace environment will be introduced during the course of the

public comment and hearing period of this rulemaking proceeding.

A standard for control of occupational exposure to dust also has the potential for affecting the external air quality, water quality, waste disposal (a function of land use, air quality and water quality), energy consumption, and human resources. These will be discussed in the following section on environmental impacts external to the workplace. Economic costs of implementing an occupational health standard have also been determined to have the potential for impacting the general human environment. A summary of these costs is given in the following discussion.

A. ENVIRONMENTAL IMPACT—EXTERNAL TO WORKPLACE

This section discusses the anticipated impacts, accruing to the general human environment external to the workplace, which may result from implementation of the proposed standard for control of cotton dust exposure in the workplace. The bulk of the analysis is concerned with the impacts resulting from exposure control in cotton gins and cotton textile mills. Data on the effects of exposure control in other industries, such as waste processing and cottonseed oil production were largely unavailable, but what information was obtained in those areas has been presented.

In a general sense, reduction of cotton dust exposures in these industries will involve improved housekeeping practices and improved methods for the collection and removal of cotton dust from the workplace. It is not anticipated that these actions will result in any significant adverse impact to the general human environment external to the workplace with respect to ambient air quality, water quality or solid waste. This conclusion, however, is judgemental, and is based on the similarity of these industries with other textile mills rather than on evaluation of actual data. Information on the potential for environmental impact resulting from implementation of OSHA's proposed standard in these other industries will be solicited during the rulemaking proceedings.

1. *Air Quality.* In assessing the impact of the cotton dust regulation on air quality, cotton ginning, since it is basically an open air operation, must be considered separately from textile mills and the rest of the cotton industry. Cotton gins are usually not entirely enclosed, but consist of various cleaning and ginning machinery under a roof, yet exposed to outside wind. Therefore machine emissions are easily transported into the ambient atmosphere, while the workplace itself is exposed to dust and particulates blown in from the surrounding environment. In addition, large volumes of dust-laden outside air are drawn into the gin for use in the pneumatic transport systems.

Cotton gins contribute varying degrees of suspended particulates to the atmosphere, depending upon the air pollution control devices installed on the exhausts (i.e., cyclones, lint cleaners, inline filters). (*79*) The composition of these particulates is fine-leaf trash, dust, lint and other trash generated during each step of the ginning process. It has been reported that the total particulate matter emissions of a typical gin, processing machine picked cotton at a rate of 10 bales per hour, varied from an average of 13.5 pounds to as high as 30 pounds of dust per hour. (*80*) Because stripper harvested cotton contains more trash, the total emissions from gins processing 10 bales/hour of stripper cotton, can range as high as 6–72 pounds per hour. (*81, 82*) Air pollution surveys conducted in Texas, near gins processing stripper cotton, have demonstrated increased suspended particulate level downwind from the ginning operations. (*79, 83, 84*) One study reported downwind particulate sample 5 to 18 times greater than those simultaneously measured upwind (upwind 487 ug/m^3; downwind 8800 ug/m^3). (*83*) Other data has also shown increased levels of fungi and bacteria measured downwind from cotton gins.(*84*)

The major sources of dust in ginning are the gin stands, lint cleaners, and bale press. Capture and filtration of air by redesign of the press plus maintaining negative air pressure in lint cleaners expected to be sufficient to achieve dust concentrations generally of both 500 ug/m^3 vertically elutriated (V.E.) dust and 200 ug/m^3 V.E.(*76*) However, contamination from atmospheric dust could present a significant problem in attaining levels lower than 200 ug/m^3 V.E.

In heavily polluted areas particulate values up to 2.0 mg/m^3 have been reported. (*85*) In the textile center of Greenville, SC, the median airborne particulate concentration measured in 1966 was 0.084 mg/m^3 and the 90% concentration was 0.15 mg/m^3.(*86*) When the gin emissions are added to this background level, the resulting particulate concentration of the atmosphere surrounding the gin will normally be well in excess of 0.1 mg/m^3.(*87*) Therefore, in order to achieve dust concentrations within the gin of 0.2 or 0.1 mg/m^3, the ginning process would need to be enclosed in a building provided with air filtering and air conditioning systems. Furthermore, it is likely that additional enclosures of dust emission sources will need to be implemented on the gin stands themselves to complement or replace the local ventilation hoods. Because of the need of visibility, complete enclosure of this machinery is infeasible. An alternative to this would be a redesign of the gin stands with the objective of keeping dust emissions to a minimum.

Since ginning contributes directly to the dust levels of the ambient air, any reduction of emissions by way of compliance with occupational health regulations will be beneficial to the external atmosphere as well. The most drastic reduction in ambient air pollution would occur as a result of enclosing the ginning machinery within an air conditioned building, which would essentially eliminate all contamination of the external atmosphere by industrial dust. This solution, however, since it would be required only to achieve the lowest levels of occupational exposure, and because of its economic infeasibility, is highly unlikely to be adopted. Application of cyclones, lint fly catchers, inline filters and condensor coverings will reduce the discharge of a significant portion of airborne emissions from the various cotton gin operations. It is estimated that 95 percent of the total lint and trash processed by ginning operations can be effectively controlled through proper application of control equipment. Quantification as to the extent of this reduction of particulate matter is not available. In any case, any reduction in industrial airborne dust levels would effect a similar reduction in ambient air pollution and would result in a relative increase in solid waste accumulation.

The major factors influencing levels of dust and lint liberated in the textile mills are the quality of cotton received from the ginning operations and processing conditions at the textile mill.(*88*) Cotton quality as it is received at the textile mill is dependent upon the variety of cotton, conditions under which it was grown, harvesting method and ginning practices. The significant difference in the trash content of cotton harvested by machine picking versus machine stripping has already been indicated. Significant progress has been made in the past years in reducing the trash content of cotton received at the mills (5.2 percent in 1946 to 2.8 percent in a comparable grade 1974 crop). This improvement is attributable mainly to better ginning techniques and increased use of cleaning machinery at the gin, especially lint cleaners. If the proposed reduction in occupational cotton dust exposures requires that ginning operations further clean the cotton through application of additional lint catchers, cotton dust levels within textile mills would be reduced as a consequence. Tests conducted by Cotton Incorporated have demonstrated that using lint cleaners at the gin actually causes airborne dust levels to be lower in the carding rooms of yarn mills.(*89*).

The various operations in cotton textile mills consist of opening, picking, carding, drawing, roving, spinning, winding, spooling, twisting, warping and weaving. Opening, picking, carding are the operations subject to the greatest amounts of airborne dust and lint in textile mills. The weaving operation also generates relatively high dust counts, however, the bulk of weave room dust apparently consists of the starch sizing used to treat the yarn, and not cotton dust.(*76*)

While dust concentrations vary among operations, control methods are basically the same throughout the textile mill. Effective dust removal depends on capture devices and efficient filtration methods. The degree of control can range from simple local exhaust ventilation to complete enclosure of machinery. The control methods required to achieve various levels of airborne dust concentration are roughly as follows: 1000ug/m^3 total dust (T.D.) concentration can be expected with dust capture devices and single stage filtration; 500ug/m^3 vertically

elutriated (V.E.) dust concentration can be achieved with two-stage filtration and air washing; 200ug/m³ V.E. will result from three-stage filtration and air washing; and 100ug/m³ V.E. would require complete equipment enclosure and stringent filtering of both recirculated and make-up air.(*76*)

It might seem that the exhausting of increased amounts of dust from the workplace air would result in greater contribution to the pollution in the ambient air surrounding the plant, but this is not the case. Direct exhaust to the external environment would be a violation of ambient air quality standards. It might also result in inadvertent reintroduction of high dust content air into the plant, negating the effect of the exhaust system. But the most compelling reason preventing the exhaust of workplace air is that it would represent a loss of air which has been conditioned for humidity and temperature as a quality control measure and would necessitate conditioning of make-up air, at substantially higher cost.(*90*)

Instead, the dust-laden air is processed through a filtration system and then returned either directly or via the central air conditioning system to the workplace. The collected dust ultimately accumulates in the waste house, increasing the amount of solid waste produced, as in ginning. Finally, textile mills do not now seem to contribute appreciably to air pollution in the surrounding environment, nor should they as a result of OSHA's regulation of cotton dust in the workplace.

Dust concentrations of 500 μg, 200 μg and lower can likewise be expected through similar control methods in waste processing and cottonseed oil mill.(*76*) There are not now any such stringent control systems in use, nor is there any data available from which to predict accurately the degree of control necessary to achieve specific exposure limit. But the similarity of the waste processing operations to yarn processing indicates that dust capture and filtration methods would be applicable to both. OSHA requests that further information on controls in these industries as well as in ginning, and on the environmental impacts of such measures be submitted during the public review and hearing period.

Before proceeding with a discussion on the disposal of gin trash, it should be pointed out that the U.S. Department of Agriculture, through its Agricultural Research Service, has been responsible for developing, testing and applying air pollution control technology to cotton ginning operations. For the most part, this research has centered around the application of high-efficiency cyclones and filters as a means to control atmospheric discharges.(*80, 91, 92, 93, 94, 95, 96*) There have been attempts by others to control emissions through skimmers.(*97*) and wet-scrubbing techniques,(*98, 99*) however, most cotton gins in the U.S. use high-efficiency cyclones and screen coverings on their condenser exhausts or inline filters for final lint control. Additionally, the Environmental Protection Agency is currently developing a source assessment document on cotton gins which contains emission factors and assesses the effect of ginning operations on ambient air quality. However, this report is still in the draft stage and is not presently available for distribution.

2. *Solid waste impact.* A second potential source for environmental contamination is the generation of solid waste. As stated above, reducing worker exposure to cotton dust will require collection of emissions, thus increasing the amounts of solid waste to be disposed. However, the bulk of the waste (i.e., burs, sticks, stems, leaves, and lint) is already being collected for reprocessing in a variety of ways to be discussed further on. Reducing worker exposure involves collecting the very fine, respirable dust that has been shown to be harmful to health. However, the actual amounts of this dust will probably be insignificant when compared to the tonnages of gin trash generated by modern gins.

When machine-picked cotton is ginned, this trash accumulates at the rate of 150 to 225 pounds per bale, and at about five times that rate for machine-stripped cotton.(*100*) Where space is not a limiting factor, and where the gin is located in a sparsely inhabited area, gin trash can be accumulated in an open pile and hauled away at the end of a season. In more densely populated areas, it may be collected in a truck or trailer and hauled away as a load accumulates. Optimally, the waste is stored in an enclosure designed to prevent it from blowing or scattering over the premises while it is being accumulated. Where large volumes of waste material are being handled within short periods of time, elevated storage hoppers are sometimes used.(*101, 102, 103*) The transfer of gin trash into or out of these various storage facilities and the transportaton by trucks could present a fugitive dust problem if proper care is not taken.

During the 1965–66 season, prior to strict clean air regulations and early harvest mechanization, a beltwide survey conducted by USDA showed that 37 percent of all gin trash was burned, 58 percent was hauled directly to the farm for use as an organic mulch on cropland, and the remaining 5 percent was disposed of by some other method.(*104*) However, under the Clean Air Act of 1970, open burning of gin trash is prohibited in all cotton-producing states with the exception of West Texas, where a high incidence of Verticillium Wilt prevents the return of gin waste to the land. Additionally, incinerating trash in "Teepee" or "Wigwam" burners is being discouraged by state air pollution agencies who now require that multiple-chamber incinerators be used.(*101*) Because of these restrictions on disposal, potential uses of gin trash are presently being investigated. Three major possibilities have been reported: cotton gin trash as a cattle feed; use of cotton gin trash as an organic mulch for cropland; and heat recovery from gin trash incineration.

In the West Texas areas, large tonnages of gin trash are used in cattle feed. Gin trash is a ruminant roughage of moderate protein and energy value. It can increase the carrying capacity of any range operation where year-round natural feed is limited.(*105*) It cannot be used if it has been contaminated by chemicals (i.e., herbicides, insecticides and especially arsenic acid dessicants).(*106*) And detoxification of trash contaminated by pesticides has not been shown to be feasible.

Gin trash can serve as a good cropland organic mulch if disease and other problems can be overcome. Composting has proved effective in destroying the Verticillium Wilt organism and in reducing weed seed viability.(*100*) However, if not properly handled, composting can become a nuisance by emitting offensive odors.

One of the most attractive applications of gin trash is incineration for production of heat to be used in the drying operation within the cotton gin. It is recommended that the moisture content of seed cotton be maintained between 6–8 percent; therefore, in cotton growing areas of relatively high humidity, dryers are used to bring the moisture level into the proper range.(*107*) It has been reported that incineration of machine-picked cotton trash will reduce the volume of the trash about 92 percent and produce from 1 million to 1.5 million BTU's bale. (*100*) A study conducted by Cotton Incorporated concluded that heat-recovery incineration would eliminate the need for 85 percent of the natural gas otherwise used for cotton drying if 30 to 35 percent of the total heat could be extracted.(*108*) They reported that the system worked well with the exception of creating particulate emissions in the stack gas. In view of the present concern over energy resources, the approach appears to be an attractive option for gin waste disposal. However, there does seem to be a conflict between saving energy and current clean air policy which will have to be resolved before this method is employed on a large scale.

Solid waste in the form of lint and other trash is generated during the yarn production process in cotton mills. This material is collected by filters and is ducted to a waste house where it is processed into a mat form by passing through a condenser. The waste fibers are doffed continuously into a receptacle located beneath the condenser. "A modern high-speed cotton card, for instance, producing 40 pounds of cotton sliver per hour, may produce 1.6 pounds of waste per hour. It is obvious, then, that a production unit of 39 such cards (which is not uncommon) would produce a 500 pound bale of waste in every 8 hour working shift."(*109*) This waste in turn may be sold to cotton waste processors to be used as batting, non-woven fabric and surgical dressings, mattresses and bedsprings, and spun yard.(*76*) Reducing worker exposure to cotton dust will involve collecting more lint-fly and trash from the work environment and thus will increase to some degree the amount of solid waste to be handled. Data is not

presently available on the additional amounts of this waste which will be collected as a result of this proposal. However, it is not believed that from an environmental standpoint, this additional amount of waste will cause unique problems relative to its sale or ultimate disposal. Throughout its processing, waste undergoes filtering and refinement. The material which is ultimately left over consists primarily of trash. The additional amounts of fly and fine dust collected as a result of OSHA's regulation, if not used in the products of waste processing, will contribute only a miniscule amount to the quantity of trash which is already being disposed, usually in landfills. Therefore, the solid waste impact resulting from this proposal is not considered to be significant. More information on the potential for solid waste impact will be solicited during OSHA's rulemaking proceeding.

3. *Water quality.* Wet-control methods to reduce worker exposures to cotton dust have not been identified as a probable method of compliance for the cotton ginning industry, and fewer than five gins in the United States utilize wet-scrubbing techniques to control air pollution emissions.(*76*) Additionally, past practices of dumping gin trash directly into streams and waterways has ceased in almost all instances.

Compliance with reduced occupational exposure limits for cotton dust in textile mills will most likely involve increased hooding and capture devices and multiple-staged filtration of recirculated air. Since these mills are air conditioned, they presently employ air washing (with water) as part of the means to accomplish temperature and humidity control. However, these air washers are not designed as efficient air cleaners. The greater the dust and lint load allowed to enter these washers, the more maintenance they will require. Therefore, the air washers are usually preceded by some form of precleaner to prevent lint from entering.(*76*)

Wet separating techniques have been utilized to control dust exposure in other industries, however, they are not believed to be practical for cotton mills for a variety of reasons. The use of a wet separator preceding the air washer would make humidity control by the air washer more difficult.

Secondly, wet waste is more difficult to handle and reuse than dry waste. Finally, a wet dust separtor is likely to become inoperable if significant amounts of waste enter with the dust because of inefficiency or malfunction of the separating or concentrating equipment preceding the dust separator. (*109*)

For the above reasons, it does not appear that wet-control methods are of practical use in controlling cotton dust in textile mills. Thus, it is reasonable to assume that there will be no increased wastewater effluent generated because of the proposed standard. Consequently, it appears that there will be no significant water quality impact as a result of reducing occupational exposures to cotton dust.

4. *Human resources.* The Technological Feasibility Assessment and Inflationary Impact Statement on the cotton dust proposal estimated that OSHA's regulation would effect a reduction in employment in the cotton industry of 1,018, 9,902, and 30,089 for the exposure levels of 0.5, 0.2, and 0.1 mg/m^3, respectively. These figures represent a range of percentage reductions throughout the industry from 0.1 to 4.3 percent. At the same time, in some areas increases in manpower requirements would occur of 859, 3,257, and 4,628 for the exposure levels of 0.5, 0.2, and 0.1 mg/m^3. These additional manpower requirements are expected to be easily satisfied by internal or regional labor, with the exception of certain highly skilled personnel, such as industrial nurses and hygienists. (*76*)

In general, the additional manpower resources that will be needed by the various cotton industries represent a negligible portion of total employment levels. This is not true for the cotton ginning industry, however, where a manpower increase of 47 percent is predicted. The seasonal nature of the industry should alleviate the problem somewhat and local labor supplies should be sufficient for the remaining industries.

Workers required for operation and maintenance of control equipment and personnel. Other personnel can be trained to sample with the vertical elutriator. The relatively small amount of physician time required for training personnel and for medical counselling can normally be acquired from physicians practicing in the vicinity.

Based on the assumption that every plant would require at least one nurse to administer the questionnaire and conduct the pulmonary function test, it was estimated that over 1000 nurses would be needed. Assuming half-time hires, this would amount to about 500 full-time equivalents. Also, an additional 30 industrial hygienists will be required. The shortage of hygienists in 1973 was estimated at 5000; the number being trained is increasing each year. While it will be difficult to fill these specialized manpower requirements, the number required by the cotton industry is only a small percentage of the demand nationwide, thus the impact of OSHA's regulation on this labor market will not be significant.

5. *Energy use impact.* The Technological Feasibility Assessment and Inflationary Impact Statement evaluated the increases in energy consumption that would be necessitated by implementation of the proposed standard 200 ug/m^3 as well as for two alternative permissible exposure limits, 500 ug/m^3 and 100 ug/m^3.

In the yarn industry, the additional energy requirements and energy costs are significant for all three exposure limits. An additional 4.9 16.0 and 34.7 trillion BTU's per year (855×10^9, 2819.0×10^3 and 6107×10^3 barrels of oil equivalent) will be required to meet the 500, 200 and 100 ug/m^3 limits, respectively, in the SIC codes examined. These additional energy requirements will cost 21, 68 and 147 million dollars annually at the 1975 electricity price, and the additional BTU requirements represent an increase of 3.5, 11.6 and 25.1 percent over the current energy consumption by the six SIC sectors examined. With respect to the total U.S. energy requirements, however, these amounts are insignificant.

The additional energy requirements are significant for the ginning, weaving, and waste processing industries at the proposed 200 ug/m^3 exposure limit as well as at the alternative 100 ug/m^3 limit. They are occasionally significant for the 500 ug/m^3 limit also. For the individual industries, the proposed standard (200 ug/m^3 will require a 74.7 percent increase (680,400 barrels of oil equivalent) in energy requirements for the ginning sector and over 21 percent (3,513,200 barrels of oil equivalent) for the cotton weaving sector.

The 100 ug/m^3 limit would require an 87.1 percent increase (793,600 barrels of oil equivalent) in energy consumption (above 1972 energy consumption levels) in the ginning industry, a 60.1 percent increase (9,977,400 barrels of oil equivalent) in the cotton weaving industry, and a 35.9 percent increase (99,400 barrels of oil equivalent) in SIC Code 2293 (Padding and Upholstery Fillings). Percent increases for SIC Codes 2294 and 2515 were 16.9 (36,800 barrels of oil equivalent) and 15.9 (77,500 barrels of oil equivalent). The total dollar cost of the additional energy requirements of the 100 ug/m^3 exposure limit for ginning, weaving, cotton waste processing, and mattresses and bedsprings is almost $284 million at 1975 energy prices; the cost is almost $120 million for the proposed standard's exposure limit. These energy and energy cost requirements are insignificant with respect to total U.S. requirements, however.

6. *Economic impact.* The following summary of economic impacts is taken from the study of the Technological Feasibility and Inflationary Impact Statement of the proposed cotton dust standard prepared for OSHA by Research Triangle Institute.

The total additional capital requirements in the yarn industry were estimated to be $984.4 million. The sectors of ginning, weaving, cotton waste and linters consumers will experience additional capital requirements totalling $1,687.2 million.

The total annualized costs for the yarn industry will be $241.6 million, and $90.4, $343.5, and $12.8 million for ginning, weaving, and waste consumers, respectively.

The average price increases per dollar of sales in yarn industry, to maintain pre-standard rates of return on investment, rage from 0.22 cent to 6.25 cents. In the yarn spinning and weaving industries price increases range from 0.01 cent to 0.17 cent.

The general inflationary impacts in the ginning, weaving, and waste consumer industries altogether are estimated to increase the Consumer Price Index (CPI) by 0.37 percent. The inflationary impacts in the yarn industry will increase the CPI by 0.143 percent.

Cotton yarn consumption is estimated to decrease by 58.3 million pounds, and the total contraction of raw cotton consumption resulting from compliance in ginning, spinning, and yarn processing will be 113 million pounds.

The impact of the proposed standard on the weaving sector will be quite severe, and it is doubtful whether those firms could compliance costs internally, if at all.

The costs of control for the cottonseed oil industry are so small as to have a negligible impact on the variables analyzed.

B. IMPACTS OF ALTERNATIVE SOLUTIONS

Section IV of this document outlines the alternatives considered by OSHA in the area of controlling employee exposure to cotton dust. As with most occupational health sandards, alternatives usually fall into two main categories: alternatives concerned with the substances to be regulated, and alternatives concerned with the level to which the chosen substance will be regulated. Earlier sections of this preamble have outlined the difficulties associated with the determination of the substance or substances contained in cotton dust which cause byssinosis. The preamble also discusses the alternative ways in which cotton dust exposure could be measured (vertical elutriated, respirable fraction, total dust, etc.)

Regardless of the alternative chosen the impacts of an OSHA regulation for cotton dust can be summarized as follows: the more cotton dust emitted from the workplace into the air or into water systems, the greater the potential for adverse impacts on air and/or water quality. Depending upon the levels of cotton dust present in the ambient air and water of communities surrounding cotton-processing industries, however, better control of cotton dust exposures in the workplace may have the potential for benefitting the general human environment of nearby areas as a result of limiting fugitive emissions and controlling point source emissions. In any event, controlling employee exposure to a level lower than that required under the current standard (29 CFR 1910.1000) should not necessarily produce a significantly adverse effect on the external environment.

The key factor is the method chosen by the employer for the purpose of compliance with the required exposure level. If control of employee exposure were achieved by methods which collect the exhausted dusts, logically, air quality in the neighborhoods surrounding cotton-processing plants may be improved. Similarly, the method of dust collection and disposal could impact water quality and solid waste categories.

Presently, OSHA has no data which quantify these potential impacts. Submissions of this type of data into the record of this proceeding are encouraged.

Alternatives for process control of the health hazards associated with cotton dust exposure, i.e., controls which do not concern varying permissible exposure limits, were also considered. For example, the washing of raw cotton has been shown to reduce or eliminate its potential for causing byssinosis. Literature sources have also revealed beneficial effects from washing, steaming, claving and use of better grades of cotton in textile mills. However, washing cotton was reported to change the characteristics sufficiently to interfere with processing it into yarn and autoclaving presents practical application problems. Steaming, however, has been tested in actual plant operations. The results of this study revealed that steaming improved the decrement in forced expiratory volume, especially in dusty operations such as opening, picking, blending and carding, but less in spinning and twisting. An approximately 30 percent reduction in total and elutriated dust levels was also achieved, yet no significant reductions in the symptoms of byssinosis were observed. Recommendations of the study still supported dust control as the primary means to prevent byssinosis. However, it did conclude that steaming could be used as an adjunct method where these measures are not effective, or as an interim measure where suitable dust control is not practical or feasible at the present time.(*28*) Merchant, et al., also observed an improvement in change in FEV, but at the same time they noted a post-preparation increase in dust levels, due possibly to adherence by the dust to cotton fibers because of the steaming. (*110*)

Among long-term solutions currently being researched are: cotton varieties which shed their bracts prior to maturation and harvest, dwarf determinant cotton with increased fruiting potential relative to the production of vegetative parts, raw chemicals that will more efficiently defoliate cotton and thereby reduce the trash content of harvested seed-cotton, field extraction of trash, which could reduce gin emissions up to 35 percent,(*82*) improved ginning methods that will allow more efficient trash separation, and substitution by synthetic fibers.(*76*) Evaluation of the environmental impact for each of these research aims is actually beyond the scope of this statement. However, it should be cautioned that prior to introducing new chemicals or plant species into the environment, a thorough evaluation should be undertaken to determine if any adverse effects on man or his environment can be identified. As to alternatives to the other provisions of the regulation, (monitoring and surveillance, for example) it is considered that none of the alternatives would have any significant impact on the external environment.

C. RELATIONSHIP WITH OTHER FEDERAL ACTIONS

There are potentially two areas where the proposed reduction in cotton dust may overlap other Federal actions concerned with the discharge of pollutants into the environment. First, the release of air pollutant emissions into the atmosphere from cotton ginning operations, which was treated in some detail in a previous section. Under the authority of the Clean Air Act, as amended (42 U.S.C. 1857 et seq.), the Environmental Protection Agency (EPA) is responsible for safeguarding air quality. To these ends they have promulgated Federal ambient air quality standards. Even though cotton dust, per se, is not specifically regulated by EPA, emissions from gin processing and incineration of cotton gin trash are composed of suspended particulate matter for which both primary and secondary ambient air quality standards have been issued. The primary standards for particulates is 75 ug/m³ annual geometric mean; the secondary standard is 60 ug/m³. (40 CFR 50.6). In order to achieve compliance with these standards, individual states have instituted allowable emission standards for various industrial processes. For cotton gins, allowable emissions based on process weight have been promulgated by the following states: Arizona, Louisiana, Missouri, North Carolina, Oklahoma, Mississippi, Alabama, Tennessee, Texas, Arkansas and California.(*101*) Additionally, all cotton ginning states have instituted air pollution regulations to control smoke emissions from incineration of gin trash. EPA is in the process of preparing a source assessment document for cotton gins which does evaluate the air pollution potential of these operations. It is not known at this time whether emission guideline will be issued by EPA with respect to gin emissions. Nevertheless, as stated previously, there appears to be a close relationship between control of cotton dust and lint control in the ginning process and the effect on ambient air quality. Therefore, both control of workplace exposures to cotton dust and the controls on gin emission as required by clean air regulations would appear to be mutually beneficial.

The second potential overlap with other Federal actions could occur in the cotton textile mills with regard to the effluent limitation guidelines promulgated by the Environmental Protection Agency for these mills.

The Environmental Protection Agency (EPA), the National Commission on Water Quality (NCWQ) and the American Textile Manufacturers Institutes (ATMI) have categorized the wastewater effluent from cotton mills involved in yarn manufacturing and making unfinished fabrics. For comparison these subcategories are listed as follows:

EPA, Subcategory 3—Dry Processing
NCWQ, Subcategory 4—Woven Dry & Processing Mill
ATMI, Subcategory 6, 3—Greige Mills plus Woven Fabric Finishing

These common subcategories cover most greige mill operations which are relatively dry in comparison to a true wet operation (i.e. fabric finishing). Generally, the only wet operation is in the slashing of warp yarn. Slashing is the application of lubricants and sizing (starch, PVA, CMC) where the only waste generated is in the occasional dumping of starch batches and wash down of the size mixing and slasher area. (111) This waste can contain appreciable amounts of Biological Oxygen Demand (BOD), Chemical Oxygen

Demand (COD) and Total Suspended Particulates (TSS). The total waste stream of these mills is over 90 percent sanitary. The combined waste stream will generally contain 80–465 mg/1 BOD, 50 to 360 mg/1 TSS, 320 to 2000 mg/1 COD and a range of pH from 6–11. The following sets of effluent limitations guidelines have been promulgated by EPA and are applicable to dry-processing cotton mill. The 1977 guidelines require the use of Best Practical Technology (BPT), while the 1983 limitations call for Best Available Technology (BAT): (112)

	1977 (BPT)	(1983 (BAT)
BOD	[1] 0.7	0.2
TSS	.7	.2
COD	1.4	.4

[1] Units expressed in pounds pollutant/1,000 lb. product.

Since wet control methods do not appear to be the most probable method of compliance with the new permissible exposure limits to cotton dust, there will be no significant impact on water quality. Therefore, compliance with the 1977 and 1983 effluent limitations required by EPA will not be adversely affected by OSHA's proposed cotton dust standard.

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104. Pendleton, A. M., "Current Gin Trash Disposal Practices," in Control and Disposal of Cotton Ginning Wastes, A Symposium, Dallas, Texas: National Center for Air Pollution Control, PHS, HEW, May 3–4, 1966.

105. Lalor, W. F., J. K. Jones and G. A. Slater, "Cotton Gin Trash as a Ruminant Feed, "Agro-Industrial Report, Cotton Incorporated, Raleigh, N.C., January, 1975.

106. "Cotton Defoliation Guide," Texas Agricultural Extension Service, Texas A & M University, College Station, Texas, Pub. No. L–145, 1969.

107. Handbook for Cotton Ginners, U.S. Department of Agriculture, Agricultural Research Service, Agriculture Handbook No. 260, Washington, February, 1964.

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109. Cotton Dust Controls in Yarn Manufacturing. U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, National Institute

for Occupational Safety and Health, Division of Laboratories and Criteria Development, Cincinnati, Ohio, March, 1974.

110. Merchant JA, et. al., "International Studies of Cotton Steaming to Reduce Biological Effects of Cotton", Br J Ind Med 31: 261–274, 1974.

111. Textile Industry Technology and Costs of Wastewater Control, Prepared for the National Commission on Water Quality by Lockwood Greene, Architects, Engineers, Spartanburg, S.C., Comm. No. 7439.011, June, 1975.

112. Cotton Ginning in the United States, Crop of 1973. U.S. Department of Commerce, Bureau of the Census. Washington, 1974.

VIII. Public Participation

Interested persons are invited to submit written data, views and arguments on the proposed standard and on all issues raised or involved herein. Written data, views, and arguments concerning the proposal must be submitted in quadruplicate to the Docket Officer, Docket No. H–052, Room N–3620, U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, D.C. 20210, on or before March 4, 1977. Written submissions must clearly identify the provisions of the proposal addressed and the position taken with respect to each such provision. The data, views, and arguments will be available for public inspection and copying at the above address. All written submissions received will be made a part of the record of this proceeding.

In order to expedite this rulemaking proceeding and in anticipation of requests for a hearing, we are scheduling an informal public hearing, pursuant to section 6(b)(3) of the Act and 29 CFR Part 1911, to begin on April 5, 1977, in the Departmental Auditorium, 14th and Constitution Avenues, N.W., Washington, D.C.

All issues raised in this notice and all aspects of the proposed standard, including its economic, inflationary and environmental impacts, will be at issue in the hearing.

Persons desiring to appear at the hearing must file a notice of intention to appear, on or before March 4, 1977, with OSHA Committee Mangement Office, Docket No. H–052, Room N3633, U.S. Department of Labor, 200 Constitution Avenue, NW., Washington, D.C. 20210 (Telephone: 202–523–8023). The notices of intention to appear, which will be available for inspection and copying at the above address, must contain the following information:

(1) The name and address of the person to appear;

(2) The capacity in which the person will appear;

(3) The approximate amount of time required for the presentation;

(4) The specific provisions of the proposal that will be addressed;

(5) A detailed statement of the position that will be taken with respect to each provision addressed; and

(6) A detailed statement of the evidence with respect to each such provision proposed to be presented at the hearing.

OSHA has determined that strict enforcement of its procedural rules contained in 29 CFR 1911.11 is necessary for an expeditious and orderly proceeding. Therefore, the notices of intent to appear will be scrutinized closely for sufficiently detailed information concerning the position to be taken with regard to the issues specified and the evidence to be presented in support of the position. Persons filing notices of intent to appear which are not sufficiently detailed will be so informed and given seven (7) days from the date they are so informed to file a a proper notice of intent to appear. Further, the amount of time requested for each presentation will be reviewed in light of the contents of the notice of intention to appear. In those cases where the information contained in the notice of intention to appear does not seem to warrant the amount of time requested, the participant will be allocated a more appropriate amount of time and notified of this fact. The participant will have seven (7) days from the date on which he is so informed to demonstrate why the allocated time is inappropriate. In addition, all prepared statements and documents that are intended to be submitted for the record during the course of the hearing must be submitted in quadruplicate and received no later than April 1, 1977.

The hearing will commence at 9:30 a.m. on Tuesday April 5, 1977 and will be conducted in accordance with 29 CFR Part 1911. The oral proceedings will be reported verbatim and a transcript will be made available for inspection and copying to interested persons.

The Administrative Law Judge who will be designated to preside at the hearing shall have all the powers necessary or appropriate to conduct a fair and full informal hearing, including the powers;

(1) To regulate the course of the proceedings;

(2) To dispose of procedural requests, objections, and comparable matters;

(3) To confine the presentations to matters pertinent to the proposed standard;

(4) To regulate the conduct of those present at the hearing by appropriate means;

(5) In his discretion, to question and permit questioning of any witness; and

(6) In his direction, to keep the record open for a reasonable, stated time to receive written information and additional data, views, and arguments from any person who has participated in the oral proceedings.

Following the close of the hearing, the presiding Administrative Law Judge shall certify the record thereof to the Assistant Secretary. The proposal will be reviewed in light of all the oral and written submissions received as part of the record in this proceeding and appropriate action will be taken.

Accordingly, pursuant to sections 4(b), 6(b) and 8(c) of the Occupational Safety and Health Act of 1970 (84 Stat. 1592, 1593, 1599; 29 U.S.C. 653, 655, 657), Secretary of Labor's Order 8–76 (41 FR 25059), and 29 CFR Part 1911, it is hereby proposed to amend Parts 1910 and 1928 of Title 29, Code of Federal Regulations, by adding a new § 1910.1043 regulating exposure to cotton dust, by deleting the current standard for cotton dust (raw) contained in Table Z–1 of § 1910.1000, and by making conforming amendments in § 1910.19 and § 1928.21 as set forth below.

(It is hereby certified that the economic and inflationary impact of this proposed regulation has been carefully evaluated in accordance with Executive Order 11821 and OMB Circular A–107.)

Signed at Washington, D.C. this 21st day of December 1976.

Morton Corn,
Assistant Secretary of Labor.

1. In § 1910.19, paragraph (c) is proposed to be added to read as follows:

§ 1910.19 Asbestos dust.

* * * * *

(c) Section 1910.1043 shall apply to the exposure of every employee to cotton dust in every employment covered by § 1910.12, § 1910.13, § 1910.14, § 1910.15, or § 1910.16, in lieu of any different standard on exposure to cotton dust which would otherwise be applicable by virtue of any of those sections. (Secs. 4, 6, 8, 84 Stat. 1592, 1593, 1599 (29 U.S.C. 653, 655, 657) and 29 CFR Part 1911)

§ 1910.1000 [Amended]

2. Table Z–1 in § 1910.1000 is proposed to be amended by deleting the following:

Cotton dust (raw) Mg/m³	1

3. A new § 1910.1043 is proposed to be added to Part 1910, to read as follows:

§ 1910.1043 Cotton dust.

(a) *Scope and application.* This section applies to the control of employee exposure to cotton dust in all workplaces and all industries, including ginning, warehousing and compressing of cotton lint, classing and marketing of cotton lint, yarn manufacturing using cotton lint, fabric manufacturing using cotton yarn, reclaiming and marketing of textile manufacturing waste, delinting of cottonseed, marketing and converting of linters, reclaiming gin motes and batting yarn, felt manufacturing using waste cotton fibers and by-products, and other processes where cotton dust is present in the atmosphere. This section applies to operations in all industries, including "general industry", construction, maritime and agriculture, except harvesting. The section does not apply to the handling or processing of woven or knitted materials nor does this section apply to working conditions with respect to which other Federal agencies have exercised statutory authority to prescribe or enforce standards or regulations affecting occupational safety and health.

(b) *Definitions.* For the purpose of this section:

"Blow down" means the cleaning of equipment and surfaces with compressed air;

"Cotton dust" means dust present in the atmosphere during the handling or processing of cotton which may contain a mixture of many substances including ground-up plant matter, fiber, bacteria, fungi, soil, pesticides, non-cotton plant

matter and other contaminants which may have accumulated with the cotton during the growing, harvesting and subsequent processing or storage periods. Any dust present during the handling and processing of cotton through the weaving or knitting of fabric, and dust generated in other operations or manufacturing processes using new or waste cotton fibers or cotton fiber by-products from textile mills are considered cotton dust;

"Director" means the Director of the National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, or his designee;

"Secretary" means the Secretary of Labor, U.S. Department of Labor or his designee;

"Vertical elutriated cotton dust" means that fraction of cotton dust collected by a vertical elutriator according to the specifications given in Appendix A.

(c) *Permissible exposure limit.* The employer shall assure that no employee is exposed to airborne concentrations of vertical elutriated cotton dust greater than 200 $\mu g/m^3$, averaged over any eight-hour period.

(d) *Exposure monitoring and measurement.*—(1) *Monitoring program.* (i) For the purposes of this paragraph (d), employee exposure is that exposure which would occur if the employee were not using a respirator.

(ii) Within 90 days from the effective date of this section, each employer who has a place of employment in which cotton dust is present as specified in paragraph (a) of this section shall conduct monitoring, by obtaining measurements which are representative of the exposures of all the employees to airborne cotton dust over an 8-hour period. The sampling program shall include at least one determination during each shift for each job classification. The procedures for collection and analysis of environmental samples provided in Appendix A shall be followed.

(2) *Frequency of monitoring.* (i) The employer shall repeat the measurements required by paragraph (d)(1) of this section at least every six months.

(ii) Whenever there has been a production, process, or control change which may result in new or additional exposure to cotton dust, or whenever the employer has any other reason to suspect an increase in employee exposure, the employer shall repeat the monitoring and measurements required by paragraph (d)(1) of this section for those employees affected by such change or increase.

(3) *Employee notification.* (i) The employer shall notify each employee in writing of the exposure measurements which represent that employee's exposure within five working days after the receipt of the results of measurements required by paragraphs (d)(1) and (d)(2) of this section.

(ii) Whenever such results indicate that the representative employee exposure exceeds the permissible exposure limit, the employer shall, in such notification, inform each employee of the corrective action being taken to reduce exposure to or below the permissible exposure limit.

(e) *Methods of compliance.* The employer shall control employee exposure to cotton dust by the use of engineering controls, work practice controls, and respirators as follows:

(1) *Engineering controls.* (i) The employer shall institute immediately engineering.
controls to reduce exposures to cotton dust to 500 $\mu g/m^3$, except to the extent that the employer can establish that such controls are not feasible. In determining whether the institution of engineering controls is feasible, the requirement, effective August 27, 1971, to implement feasible administrative or engineering controls to reduce exposures to cotton dust shall be considered.

(ii) The employer shall institute engineering controls necessary to reduce exposures to cotton dust to 350 $\mu g/m^3$ within 4 years from the effective date of this section, except to the extent that the employer can establish that such controls are not feasible.

(iii) The employer shall institute engineering controls necessary to reduce exposures to cotton dust to 200 $\mu g/m^3$ within 7 years from the effective date of this section, except to the extent that the employer can establish that such controls are not feasible.

(iv) Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposure to the levels specified to be achieved solely by these means in paragraph (e)(1)(i)(e)(1)(iii) of this section, the employer shall nonetheless institute these controls to reduce exposures to the lowest feasible level.

(2) *Work practice controls.* The employer shall implement the work practice controls listed in paragraph (g) of this section regardless of the level of exposure.

(3) *Respirators.* Whenever the engineering and work practice controls which are instituted are not sufficient to reduce employee exposure to the permissible exposure limit (200 $\mu g/m^3$ vertical elutriated cotton dust), the employer shall supplement such controls with the use of respirators which shall comply with provisions of paragraph (f) of this section.

(4) *Compliance program.* (i) Each employer shall establish and implement a written program to reduce exposures solely by means of engineering controls, as specified in paragraph (e)(1) of this section.

(ii) The written program shall include at least the following:

(a) A description of each operation or process resulting in employee exposure to cotton dust;

(b) Engineering plans and other studies used to determine the controls for each process;

(c) A report of the technology considered in meeting the permissible exposure limit;

(d) Monitoring data obtained in accordance with paragraph (d) of this section;

(e) A detailed schedule for the implementation of engineering controls;

(f) Other relevant information.

(iii) Written plans for such program shall be submitted, upon request, to the Secretary and the Director, and shall be available at the worksite for examination and copying by the Secretary, the Director, any affected employee or their representative. The plans required under paragraph (e)(4) of this section shall be revised and updated at least every six months to reflect the current status of the program.

(5) *Mechanical ventilation.* When mechanical ventilation is used to control exposure, measurements which demonstrate the effectiveness of the system to control the exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every six months. Measurements of the system's effectiveness to control exposures shall also be made within five days of any change in production, process or control which might result in any change in airborne concentrations of cotton dust.

(f) *Use of Respirators.*—(1) *General.* Where the use of respirators is required under this section, the employer shall provide and assure the use of respirators which comply with the requirements of this paragraph (f). Compliance with the permissible exposure limit may not be achieved by the use of respirators except:

(i) During the time periods allowed to install engineering controls; or

(ii) In work operations such as maintenance and repair activity, in which engineering and work practice controls are not feasible; or

(iii) In work situations where feasible engineering and work practice controls are not yet sufficient to reduce exposure to or below the permissible exposure limits; or

(iv) In operations specified under paragraph (g)(2)(i) of this section.

(2) *Respirator selection.* (i) Where respirators are required under this section, the employer shall select and provide and assure the use of the appropriate respirator from Table 1 below.

TABLE I.—RESPIRATORS FOR COTTON DUST

Cotton dust concentration	*Required respirator*
(a) Not greater than 2000 ug/m^3 ------	(1) Any dust respirator, except single use; or (2) Any supplied air respirator; or (3) Any self-contained breathing apparatus.

(b) Not greater than 10,000 ug/m³ ------	(1) Any dust respirator with full-facepiece and high efficiency filter; or (2) Any supplied air respirator with full-facepiece; or (3) Any self-contained breathing apparatus with full-facepiece.
(c) Greater than 10,000 ug/m³ ----------	(1) Any powered air-purifying respirator with high efficiency filter; or (2) Any self-contained breathing apparatus operated in pressure demand or other positive pressure mode; or (3) Any type "C" supplied air respirator operated in pressure demand or continuous flow mode.

(ii) Respirators shall be selected from those tested and approved for protection against dust by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part 11.

(iii) Whenever respirators are required by this section for concentrations not greater than 10,000 ug/m³, the employer shall provide, either a respirator as provided in paragraph (f) (2) (i) (a) and (b) of this section or, at the option of each affected employee, a powered air purifying respirator as provided in paragraph (f) (2) (i) (c) (1) of this section.

(3) *Respirator program.* The employer shall institute a respirator program in accordance with § 1910.134 of this part.

(4) *Respirator usage.* (i) The employer shall assure that respirators used by employees exhibit minimum facepiece leakage and that the respirators are fitted properly. The employer shall perform semi-quantitative fit tests annually for each employee who uses a nonpowered, particulate filter respirator.

(ii) The employer shall allow each employee who uses a filter respirator to change the filter elements whenever an increase in breathing resistance is detected and shall maintain an adequate supply of filter elements for this purpose.

(iii) The employer shall allow employees who wear respirators to wash their face and respirator facepiece to prevent skin irritation associated with respirator use.

(g) *Work practices.* (1) The employer shall inspect, clean, maintain and repair, all engineering control equipment and ventilation systems including power sources, ducts and filtration units of the equipment pursuant to a detailed written program established and implemented for effective control of cotton dust exposure.

(2) The employer shall establish and implement a written program of work practices, to include procedures which shall minimize cotton dust exposure for each specific job. The procedures shall include the following, where applicable:

(i) The employer shall prohibit compressed air "blow down" cleaning, except where alternative means are not available, in which case respirators shall be worn by the employees present. Employees in the area whose presence is not required to perform the "blow down" shall be required to leave the area during this cleaning operation. Cleaning of clothing with compressed air is prohibited.

(ii) Floor sweeping shall be performed with a vacuum or with methods designed to minimize dispersal of dust.

(iii) Cotton and cotton waste shall be stacked, sorted, baled, dumped, removed or otherwise handled by mechanical means except where the employer can show that it is infeasible to do so. Where infeasible, the method developed and implemented by the employer shall be one which most effectively prevents the release of airborne cotton dust in excess of the permissible exposure limit.

(h) *Medical surveillance*—(1) *General.* (i) Each employer who has a place of employment in which cotton dust is present shall institute a program of medical surveillance for all employees.

(ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and are provided without cost to the employee.

(iii) The employer shall inform any employee who refuses any required medical surveillance of the possible health consequencies of such refusal and shall obtain a signed statement from the employee indicating that the employee understands the risk involved in the refusal to be examined.

(2) *Initial examinations.* At the time of initial assignment or upon the institution of the medical surveillance program, the employer shall provide each employee with an opportunity for a physical examination that shall include:

(i) A medical history;

(ii) The standardized questionnaire (Appendix B);

(iii) A pulmonary function measurement, including a determination of forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_1).

(a) These determinations will be made for the new employee prior to placement.

(b) These determinations will be made for the current employee before he enters his workplace on the first day of the work week, following at least 35 hours after previous exposure to cotton dust. The test will be repeated during the shift, no sooner than 4 and no more than 10 hours after the beginning of said work shift; and, in any event, no more than one hour after cessation of exposure.

(iv) A determination shall be made of the amount of the FEV_1, the FVC and the percentage that the measured values of FEV, and FVC differ from the predicted values, using the standard tables as set forth in Appendix C.

(v) Based upon questionnaire results, each employee shall be graded according to Schilling's byssinosis classification system.

(3) *Periodic examinations.* (i) The employer shall provide each employee with an opportunity for medical surveillance as outlined in paragraph (h) (1) and (2) of this section repeated on an annual basis. (ii) Medical surveillance shall be provided every six months for employees placed in the following categories:

(a) An FEV_1 of greater than 80 percent of predicted but with an FEV_1 decrement of 5 percent or more on a first working day,

(b) An FEV_1 of less than 79 percent of the predicted value.

Updated questionnaires shall be required every six months for employees in this category, and a detailed pulmonary examination is required for employees whose FEV_1 is less than 60 percent of the predicated value.

(c) Where in the opinion of a physician, a significant change in questionnaire findings, pulmonary function results or other diagnostic tests has occurred.

(iii) A comparison shall be made between the current examination results and those of previous examinations and a determination made by the physician as to whether there has been a significant change.

(4) *Information provided to the physician.* The employer shall provide the following information to the examining physician:

(i) A copy of this regulation and its Appendices;

(ii) A description of the affected employee's duties as they relate to the employee's exposure;

(iii) The employee's exposure level or anticipated exposure level;

(iv) A description of any personal protective equipment used or to be used; and

(v) Information from previous medical examinations of the affected employee which is not readily available to the examining physician.

(5) *Physician's written opinion.* (i) The employer shall obtain and furnish the employee with a copy of the written opinion from the examining physician containing the following:

(a) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to cotton dust;

(b) Any recommended limitations upon the employee's exposure to cotton dust or upon the use of equipment such as respirator; and

(c) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment.

(ii) The employer shall instruct the physician not to reveal in the written

opinion specific findings or diagnoses unrelated to occupational exposure.

(i) *Employee education and training.* (1) Each employer who has a workplace where airborne cotton dust is present as described in paragraph (a) of this section shall:

(i) Keep a copy of this regulation with its appendices at the workplace and make such material readily available to employees.

(ii) Inform employees who work or will be assigned work in the presence of cotton dust of the specific nature of the operations which could result in exposure at or above the permissible exposure limit.

(2) Each employer who has a workplace where airborne cotton dust is present shall provide, prior to initial placement of new employees and at least annually for all employees, a training program which shall inform each employee of:

(i) The measures, including work practices, required by paragraph (g) of this section, necessary to protect them from exposures in excess of the permissible exposure limit;

(ii) The purpose, proper use and limitations of respirators as required by paragraph (f) of this section;

(iii) The purpose for and a description of the medical surveillance program required by paragraph (n) of this section, including information on the signs and symptoms of byssinosis and other respiratory diseases related to exposure to cotton dust;

(iv) A review of this standard.

(3) The employer shall provide all materials relating to the employee training and information program to the Secretary and the Director upon request.

(j) *Signs.* The employer shall be required to post signs wherever respirators are required to be used by this section, which state:

RESPIRATORS REQUIRED IN THIS AREA

(k) *Recordkeeping*—(1) *Measurements.* The employer shall establish and maintain an accurate record of all measurements taken to monitor employee exposure to airborne concentrations of cotton dust required in paragraph (d) of this section.

(i) This record shall include the log as required by paragraph IV(a) of Appendix A, and:

(*a*) The type of protective devices worn, if any and length of time worn; and

(*b*) The name, social security numbers, job classification, and exposure levels of employees in the involved workplace.

ii) This record shall be maintained for at least 20 years.

(2) *Medical surveillance.* The employer shall establish and maintain an accurate medical record for each employee subject to medical surveillance as required by paragraph (h) of this section.

(i) The record shall include:

(*a*) The name and social security number and description of duties of the employee;

(*b*) A copy of the medical examination results;

(*c*) A copy of the physician's written opinion;

(*d*) Any employees medical complaints related to exposure to cotton dust; and

(*e*) The signed statement of any refusal to have medical surveillance under paragraph (h) of this section.

(ii) This record shall be maintained for at least 20 years.

(3) *Availability.* (i) The employer shall make available upon request all records required to be maintained by paragraph (k) of this section to the Secretary and the Director for examination and copying.

(ii) The employer shall make available upon request records of employee exposure measurements required by paragraph (k)(1) of this section for inspection and copying to affected employees, former employees, and their designated representatives.

(iii) The employer shall make available upon request employee medical records required to be maintained in paragraph (k) of this section to a physician designated by the affected employee or former employee.

(4) *Transfer of records.* (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (k) of this section.

(ii) Whenever the employer ceases to do business, and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted by registered mail to the Director.

(iii) At the expiration of the retention period for the records required to be maintained under paragraph (k) of this section, the employer shall transmit these records by registered mail to the Director or shall continue to retain these records.

(l) *Observation of Monitoring.* (1) The employer shall provide affected employees or their representatives an opportunity to observe any measuring of employee exposure to cotton dust conducted pursuant to paragraph (d) of this section.

(2) Whenever observation of the measuring or monitoring of employee exposure to cotton dust requires entry into an area where the use of personal protective equipment is required, the employer shall provide the observer with and assure the use of such equipment and shall require the observer to comply with all other applicable safety and health procedures.

(3) Without interfering with the measurement, observers shall be entitled to:

(i) An explanation of the measurement procedures;

(ii) Observe all steps related to the measurement of airborne cotton dust performed at the place of exposure; and

(iii) A record of the results obtained.

(m) *Effective date.* This standard shall become effective 90 days after publication of the final standard in the FEDERAL REGISTER.

(n) *Appendices.* The information contained in the appendices of this section are part of this section.

APPENDIX A

AIR SAMPLING AND ANALYTICAL PROCEDURES FOR DETERMINING CONCENTRATIONS OF COTTON DUST

I. SAMPLING LOCATIONS

The sampling procedure must be designed so that samples of the actual dust concentrations are collected accurately and consistently and reflect the concentrations of dust at the place and time of sampling. At least five 6-hour area samples in each distinct operational area of the plant shall be collected at locations which provide representative samples of air to which the worker is exposed. Samples in each operating area shall be gathered simultaneously during a normal operating period. The daily time-weighted average (TWA) exposure of each worker can then be determined by using the following formula:

$$TWA = \frac{\text{summation of hours spent in each location} \times \text{the dust concentration in that location}}{\text{Total hours exposed}}$$

A time-weighted average concentration shall be computed for each worker and properly logged and maintained on file for review.

II. SAMPLING EQUIPMENT

(a) Sampler. The instrument selected for monitoring is the vertical elutriator. It shall operate at a flow rate of 7.4 ± 0.2 liters/minute.

The samplers shall be cleaned prior to sampling. The pumps shall be monitored and vacuums checked during sampling.

(b) Filter holder. A three-piece cassette constructed of polystyrene designed to hold a 37-mm diameter filter shall be used. To insure that an adequate seal exists between elements of the cassette, an opaque cellulose shrink band shall be placed over the joint between the center and bottom parts of the cassette.

(c) Filters and support pads. The membrane filters used shall be polyvinyl chloride with a 5-um pore size and 37-mm diameter. A support pad, commonly called a backup pad, shall be used under the filter membrane in the field monitor cassette.

(d) Balance. A balance sensitive to 10 micrograms shall be used.

III. INSTRUMENT CALIBRATION PROCEDURE

Samplers shall be calibrated when first received from the factory, after repair, and after receiving any abuse. The samplers shall be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The primary standards, such as a spirometer or a wet test meter or other standard calibrating instruments such as a large bubble meter or dry gas meter, shall be used. Instructions for calibration with the wet test meter follow. If another calibration device is selected, equivalent procedures shall be used:

(a) Level wet test meter. Check the water level which should just touch the calibration point at the left side of the meter. If water level is low, add water 1–2 F° warmer than room temperature to fill point. Run the meter for 30 minutes before calibration;

(b) Place the polyvinyl chloride membrane filter in the filter cassette;

(c) Assemble the calibration sampling train;

(d) Connect the wet test meter to the train. The pointer on the meter should run clockwise and a pressure drop of not more

than 1.0 inch of water indicated. If the pressure drop is greater than 1.0 disconnect and check the system;

(e) Operate the system for ten minutes before starting the calibration;

(f) Check the vacuum gauge on the pump to insure that the pressure drop across the orifice exceeds 14 inches of mercury;

(g) Record the following on calibration data sheets:

(1) Wet test meter reading, start and finish;

(2) Elapsed time, start and finish (at least two minutes);

(3) Pressure drop at manometer;

(4) Air temperature;

(5) Barometric pressure; and

(6) Limiting orifice number;

(h) Calculate the flow rate and compare against the flow of 7.4 $\pm$ 0.2 liters/minute. If flow is between these limits, perform calibration again, average results, and record orifice number and flow rate. If flow is not within these limits, discard or modify orifice and repeat procedure;

(i) Record the name of the person performing the calibration, the date, serial number of the wet test meter, and the number of the critical orifices being calibrated.

IV. SAMPLING PROCEDURE

(a) Sampling data sheets shall include a log of:

(1) The date of the sample collection;

(2) The time of sampling;

(3) The location of the sampler;

(4) The sampler serial number;

(5) The cassette number;

(6) The time of starting and stopping the sampling and the duration of sampling;

(7) The weight of the filter before and after sampling;

(8) The weight of dust collected (corrected for controls);

(9) The dust concentration measured;

(10) Other pertinent information; and

(11) Name of person taking sample.

(b) Assembly of filter cassette shall be as follows:

(1) Loosely assemble 3-piece cassette;

(2) Number cassette, top and bottom;

(3) Place absorbant pad in cassette;

(4) Weigh filter to an accuracy of 10 ug;

(5) Place filter in cassette;

(6) Record weight of filter in log, using cassette number for identification;

(7) Fully assemble cassette, using pressure to force parts tightly together;

(8) Install plugs top and bottom;

(9) Put shrink band on cassette, covering joint between center and bottom parts of cassette; and

(10) Set cassette aside until shrink band dries thoroughly.

(c) Sampling collection shall be performed as follows:

(1) Clean lint out of the motor and elutriator and clean the relief valve screen;

(2) Install vertical elutriator in sampling locations specified above with inlet 4½ to 5½ feet from floor (breathing zone height);

(3) Remove top section of cassette;

(4) Install cassette in ferrule of elutriator;

(5) Tape cassette to ferrule with 1 in. wide masking tape or similar material for airtight seal;

(6) Remove bottom plug of cassette and attach hose containing critical orifice;

(7) Start elutriator pump and check to see if gauge reads above 14 in. of Hg vacuum;

(8) Record starting time, cassette number, and sampler number;

(9) At end of sampling period stop pump and record time; and

(10) Controls: With each batch of samples collected, two additional filter cassettes shall be subjected to exactly the same handling as the samples, except that they are not opened. These control filters shall be weighed in the same manner as the sample filters. Any difference in weight in the control filters would indicate that the procedure for handling sample filters may not be adequate and shall be evaluated to ascertain the cause of the difference, whether and what necessary corrections must be made, and whether additional must be collected.

(d) Shipping

The cassette with samples shall be collected, along with the appropriate number of blanks, and shipped to the analytical laboratory in a suitable container to prevent damage in transit.

(e) Weighing of the sample shall be achieved as follows:

(1) Remove shrink band;

(2) Remove top section of cassette and bottom plug;

(3) Remove filter from cassette and weigh to an accuracy of 10 ug; and

(4) Record weight in log against original weight

(f) Calculation of volume of air sampled shall be determined as follows:

(1) From starting and stopping times of sampling period, determine length of time in minutes of sampling period; and

(2) Multiply sampling time in minutes by flow rate of critical orifice in liters per minute and divide by 1000 to find air quantity in cubic meters

(g) Calculation of Dust Concentrations shall be made as follows:

(1) Subtract weight of clean filter from dirty filter and apply control correction to find actual weight of sample. Record this weight (in ug) in log; and

(2) Divide mass of sample in ug by air volume in cubic meters to find dust concentration in ug/m. Record in Log.

APPENDIX B
RESPIRATORY QUESTIONNAIRE

A. IDENTIFICATION DATA

PLANT _____ SOCIAL SECURITY NO. _____
DAY MONTH (figures) YEAR (last 2 digits)

NAME _____ DATE OF INTERVIEW _____
(Surname)

_____ _____ DATE OF BIRTH _____
(First Names) M F

ADDRESS _____ AGE _____ (8,9) SEX _____ (10)

_____ RACE | W | N | IND. | OTHER | (11)

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st _____ 2nd _____ 3rd _____ (13) STANDING HEIGHT _____ (14,15)

PRESENT WORK AREA WEIGHT _____ (16,18)

If working in more than one specified work area, X area where most of the work shift is spent. If "other," but spending 25% of the work shift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which employee is assigned — if he works in more than one work room within a department classify as 7 (all) for that department.

	Workroom Number	(19) Open	(20) Pick	Area	(21) Card #1	(22) #2	(23) Spin	(24) Wind	(25) Twist	(26) Spool	(27) Warp	(28) Slash	(29) Weave	(30) Other
AT RISK (cotton & cotton blend)	1			Cards										
	2			Draw										
	3			Comb										
	4			Rove										
	5			Thru Out										
	6													
	7 (all)													
Control (synthetic & wool)	8													
Ex-Worker (cotton)	9													

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record 'No'. When no square, circle appropriate answer.

B. COUGH

(on getting up)†

Do you usually cough first thing in the morning? ____ Yes ____ No ____ (31)
(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.)

Do you usually cough during the day or at night? ____ Yes ____ No ____ (32)
(Ignore an occasional cough.)

If 'Yes' to either question (31-32):

Do you cough like this on most days for as much as three months a year? ____ Yes ____ No ____ (33)

Do you cough on any particular day of the week? Yes ____ No ____ (34)

(1) (2) (3) (4) (5) (6) (7)

If 'Yes': Which day? Mon. Tues. Wed. Thur. Fri. Sat Sun. (35)

C. PHLEGM or alternative word to suit local custom.

(on getting up)†

Do you usually bring up any phlegm from your chest first thing in the morning? (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) ____ Yes ____ No ____ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) ____ Yes ____ No ____ (37)

If 'Yes' to either question (36) or (37):

Do you bring up phlegm like this on most days for as much as three months each year? ____ Yes ____ No ____ (38)

If 'Yes' to question (33) or (38):

(cough)
How long have you had this phlegm?
(Write in number of years

(1) ☐ 2 years or less
(2) ☐ More than 2 years-9 years
(3) ☐ 10-19 years
(4) ☐ 20+ years

†These words are for subjects who work at night

D. CHEST ILLNESSES

In the past three years, have you had a period of (increased) †cough and phlegm lasting for 3 weeks or more? ____

(1) ☐ No (40)
(2) ☐ Yes, only one period
(3) ☐ Yes, two or more periods

†For subjects who usually have phlegm

During the past 3 years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?) Yes ____ No ____ (41)

If 'Yes' to (41): Did you bring up (more) phlegm than usual in any of these illnesses? Yes ____ No ____ (42)

If 'Yes' to (42): During the past three years have you had:
Only one such illness with increased phlegm? (1) ☐ (43)

More than one such illness: (2) ☐ (44)

Br. Grade ____

E. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult? _____ Yes _____ No _____ (45)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) _____ Yes _____ No _____ (46)

If 'Yes': Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun. (47)

(1) Sometimes (2) Always

If 'Yes' Monday: At what time on Monday does your chest feel tight or your breathing difficult? (48)

1 ☐ Before entering the mill

2 ☐ After entering the mill

(Ask only if NO to Question (45)

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? _____ Yes _____ No _____ (49)

If 'Yes': Which day? Mon. (3) Tues. (4) Wed. (5) Thur. (6) Fri. (7) Sat. (8) Sun. (50)

(1) Sometimes (2) Always

F. BREATHLESSNESS

If disabled from walking by any condition other than heart or lung disease put "X" here and leave questions (52-60) unasked. ☐ (51)

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? _____ Yes _____ No _____ (52)

If 'No', grade is 1. If 'Yes', proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level? _____ Yes _____ No _____ (53)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level? _____ Yes _____ No _____ (54)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing? _____ Yes _____ No _____ (55)

If 'No', grade is 4. If 'Yes', grade is 5.

Dyspnea Grd. _____ (56)

ON MONDAYS:

Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? _____ Yes _____ No _____ (57)

If 'No', grade is 1. If 'Yes', proceed to next question

Do you get short of breath walking with other people at an ordinary pace on the level? _____ Yes _____ No _____ (58)

If 'No', grade is 2. If 'Yes', proceed to next question

Do you have to stop for breath when walking at your own pace on the level? _____ Yes _____ No _____ (59)

If 'No', grade is 3. If 'Yes', proceed to next question

Are you short of breath on washing or dressing? _____ Yes _____ No _____ (60)

If 'No', grade is 4. If 'Yes', grade is 5

B. Grd. _____ (61)

G. OTHER ILLNESSES AND ALLERGY HISTORY

Do you have a heart condition for which you are under a doctor's care? _____Yes_____No_____(62)

Have you ever had asthma? Yes No (63)

If 'Yes', did it begin: (1) ☐ Before age 30
(2) ☐ After age 30

If 'Yes' before 30: did you have asthma before ever going to work in a textile mill? _____Yes_____No_____(64)

Have you ever had hay fever or other allergies (other than above)? _____Yes_____No_____(65)

H. TOBACCO SMOKING*

Do you smoke?

Record 'Yes' if regular smoker up to one month ago. (Cigarettes, cigar or pipe) _____Yes_____No_____(66)

If 'No' to (63).

Have you ever smoked? (Cigarettes, cigars, pipe. Record 'No' if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) _____Yes_____No_____(67)

If 'Yes' to (63) or (64); what have you smoked and for how many years? (Write in specific number of years in the appropriate square)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Years	(<5)	(5-9)	(10-14)	(15-19)	(20-24)	(25-29)	(30-34)	(35-39)	(>40)	
Cigarettes										(68)
Pipe										(69)
Cigars										(70)

If cigarettes, how many packs per day? (Write in number of cigarettes)
(1) ☐ less than 1/2 pack (71)
(2) ☐ 1/2 pack, but less than 1 pack
(3) ☐ 1 pack, but less than 1-1/2 packs
(4) ☐ 1-1/2 packs or more

Number of pack years: _____(72,73)

If an ex-smoker (cigarettes, cigar or pipe), how long since you stopped? _____(74)
(Write in number of years)

(1) ☐ 0-1 year
(2) ☐ 1-4 years
(3) ☐ 5-9 years
(4) ☐ 10+ years

*Have you changed your smoking habits since last interview? If yes, specify what changes.

I. OCCUPATIONAL HISTORY**

Have you ever worked in: A foundry? (As long as one year) _____Yes_____No_____(75)

Stone or mineral mining, quarrying or processing? (As long as one year) _____Yes_____No_____(76)

Asbestos milling or processing? (Ever) _____Yes_____No_____(77)

Cotton or cotton blend mill? (For controls only) _____Yes_____No_____(78)

Other dusts, fumes or smoke? If yes, specify: _____Yes_____No_____(79)

Type of exposure _____

Length of exposure _____

**Ask only on first interview.

At what age did you first go to work in a textile mill? (Write in specific age in appropriate square).

(1)	(2)	(3)	(4)	(5)	(6)	
<20	20-24	25-29	30-34	35-39	40+	(80)

When you first worked in a textile mill, did you work with (1) ☐ Cotton or cotton blend (81)
(2) ☐ Synthetic or wool

Within the first few days you first worked in a textile mill, do you remember becoming sick with fever, chills, cough or sickness of the stomach? (Accept any of the above signs or symptoms)_____Yes_____No_____(82)

If "no" to (75): Have you ever had such an illness after returning to the mill after a few days away from the mill?_____Yes_____No_____(83)

How many years have you worked in a textile mill? (Write in total number of years in appropriate square)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Processing:	<1	1-4	5-9	10-14	15-19	20-24	25-30	30+	
Cotton or Cotton Blend									(84)
All Synthetic or Wool									(85)

If cotton, how many years did you spend in each area? (Write in years in each area)

	(86) Open	(87) Pick	(88) Card	(89) Spin	(90) Wind	(91) Twist	(92) Spool	(93) Warp	(94) Slash	(95) Weave	(96) Other	
<1												(1)
1-4												(2)
5-9												(3)
10-14												(4)
15-19												(5)
20-24												(6)
25-29												(7)
30+												(8)

For those working in more than one area:

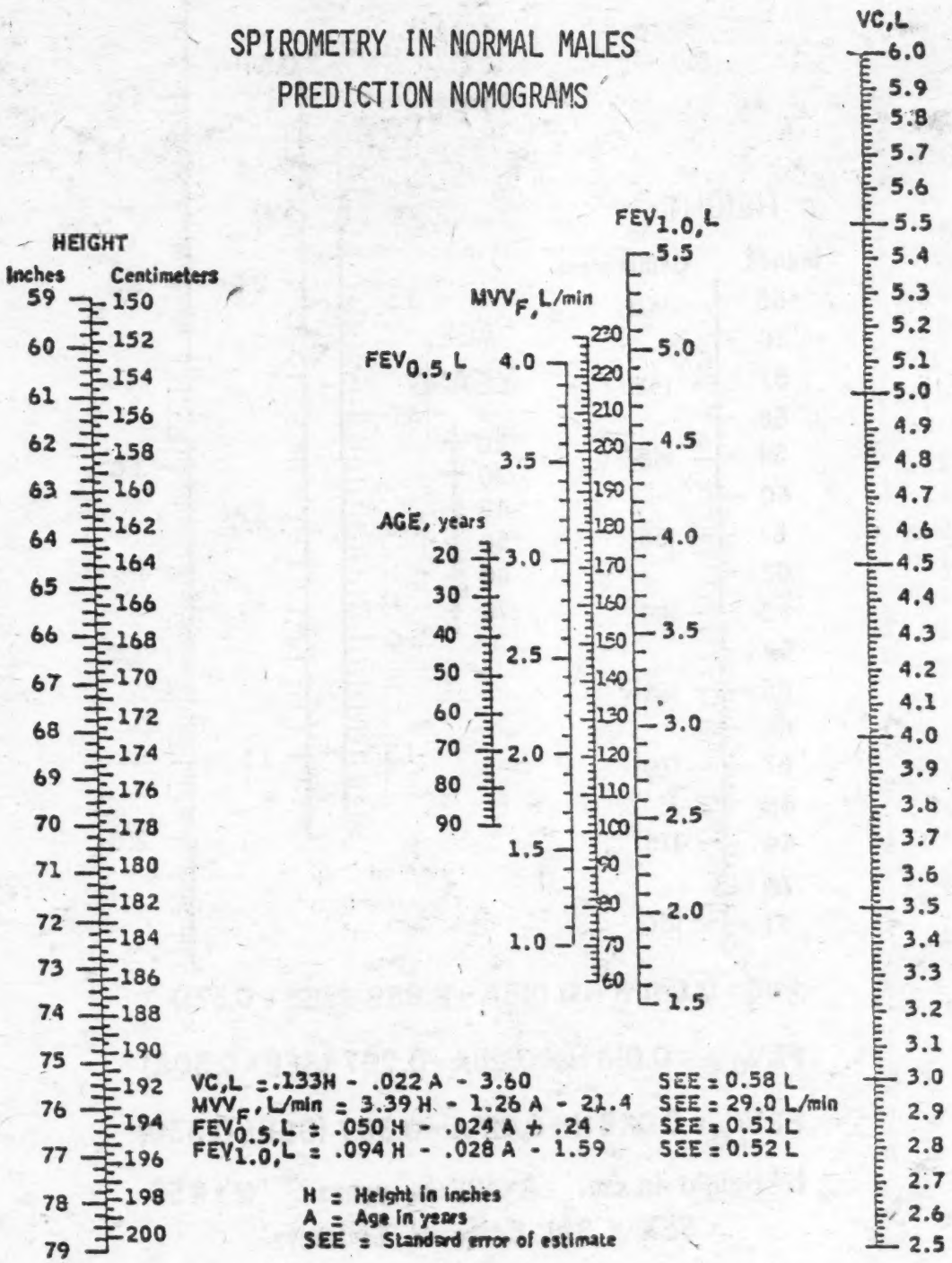
Did you move from a dusty work area to one that was not as dusty?_____Yes_____No_____(97)

If yes, did you move because the dust bothered your breathing?_____Yes_____No_____(98)

APPENDIX C

V.A. COOPERATIVE STUDY
Spirometry in Normal Males
Prediction Nomograms

SPIROMETRY IN NORMAL MALES
PREDICTION NOMOGRAMS

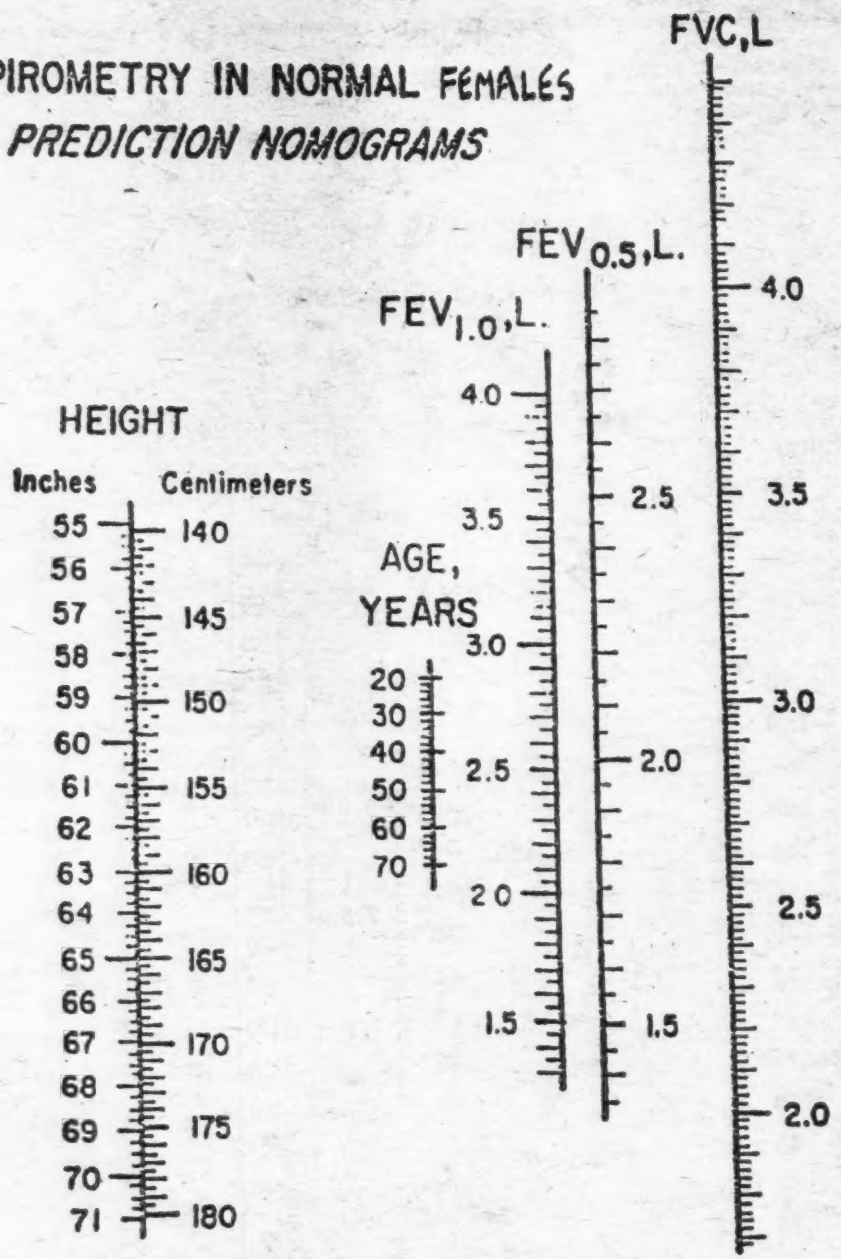


VC, L	= .133H - .022 A - 3.60	SEE = 0.58 L
MVV_F, L/min	= 3.39 H - 1.26 A - 21.4	SEE = 29.0 L/min
$FEV_{0.5}$, L	= .050 H - .024 A + .24	SEE = 0.51 L
$FEV_{1.0}$, L	= .094 H - .028 A - 1.59	SEE = 0.52 L

H = Height in inches
A = Age in years
SEE = Standard error of estimate

SPIROMETRY IN NORMAL FEMALES

PREDICTION NOMOGRAMS



$FVC = 0.041\,H - 0.018A - 2.689$ (SEE = 0.371)

$FEV_{0.5} = 0.018\,H - 0.011A - 0.297$ (SEE = 0.306)

$FEV_{1.0} = 0.028\,H - 0.021A - 0.867$ (SEE = 0.330)

H = Height in cm. A = AGE in years. N = 450

SEE = Std. Error of Estimate

The following guidelines are recommended for use in evaluating pulmonary function results in conjunction with the monograms of this appendix.

1. In black persons, the predicted value for FVC obtained from the monogram should be multiplied by 0.85 to adjust for the 15% lower FVC.

2. The measured value for FVC should not be less than 75% of that predicted for age, sex, and height.

4. In Part 1928 of 29 CFR, § 1928.21 would be amended by adding the following item to paragraph (a) of § 1928.21:

§ 1928.2 Applicable standards in 29 CFR Part 1910.

(a) * * *

(5) Cotton dust—§ 1910.1043.

(Secs. 4, 6, 8, 84 Stat. 1592, 1593, 1599, (29 U.S.C. 653, 655, 657); Secretary of Labor's Order 8-76 (41 FR 25059); 29 CFR Part 1911.)

[FR Doc.76-37893 Filed 12-22-76;2:00 pm]